

# MACHINERY

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## COLD-HEADING—1

### PRINCIPLES OF COLD-HEADING—EARLY HISTORY—TYPES OF COLD-HEADING MACHINES, ETC.

BY CHESTER L. LUCAS\* AND ERNEST W. DUSTON†

**T**HE operation of forming the heads of rivets, wood screw blanks, machine screw blanks, and similar products, by upsetting the ends of the wire lengths while cold, is known as cold-heading. The machines to which the wire is fed from a coil, and in which it is cut off and

#### Principles of Cold-heading

If you should cut off a piece of  $\frac{3}{8}$ -inch diameter copper wire about 1 inch long, stand it on end on a hardened steel block, as shown at A, in Fig. 2, and strike it squarely on top with a heavy hammer, you would upset the piece as a result of the

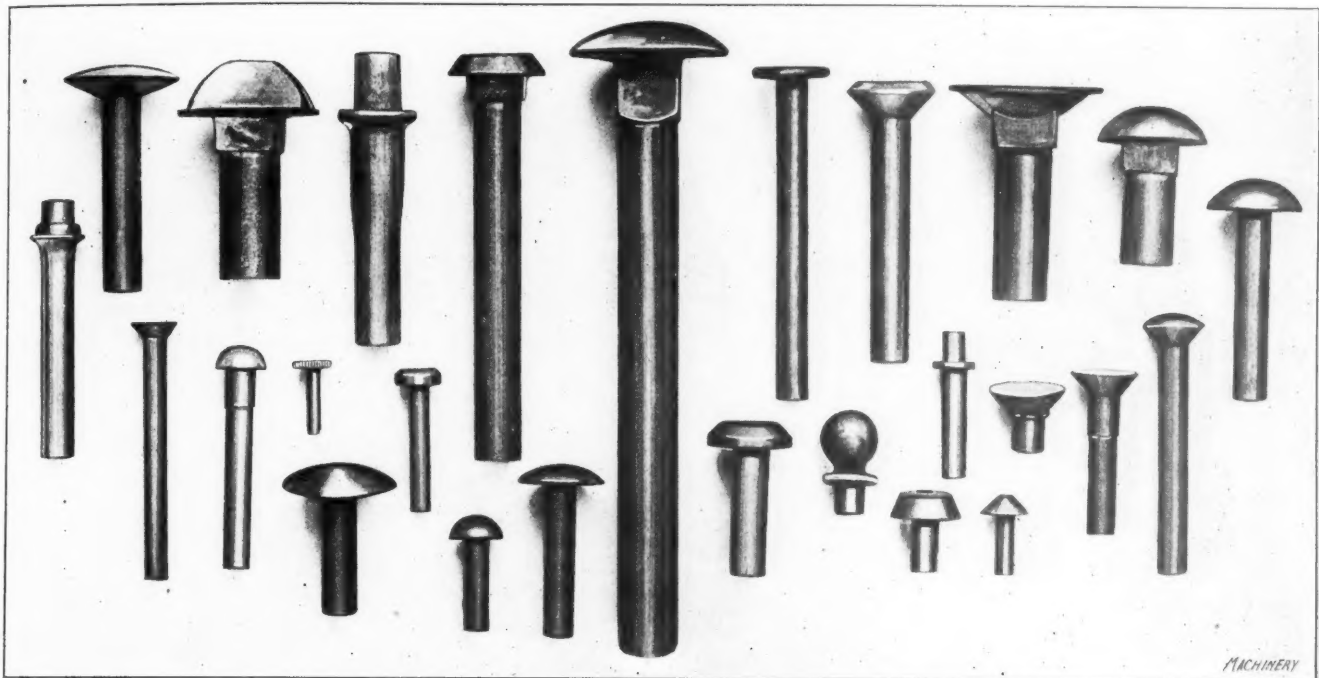
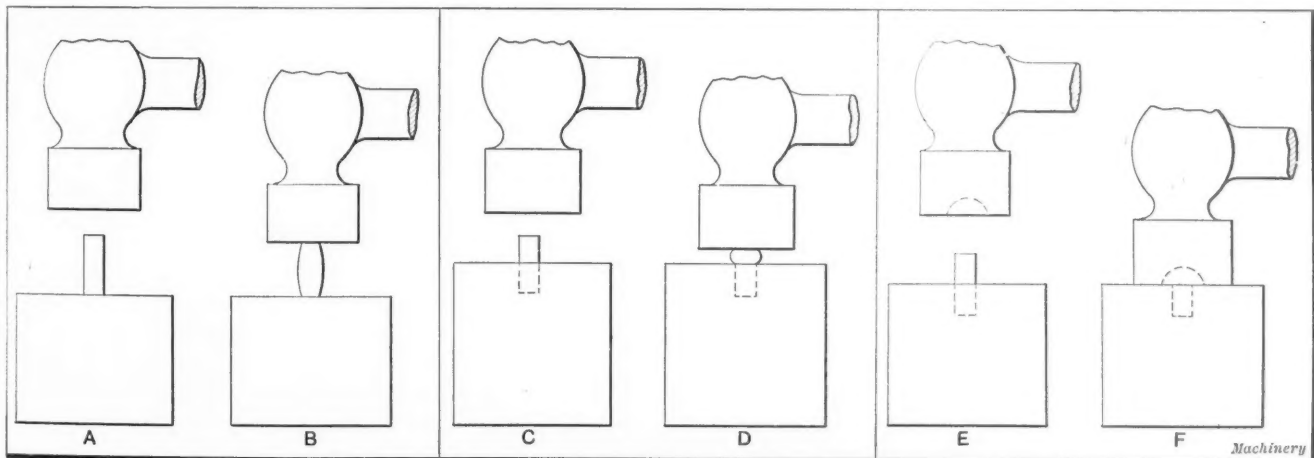


Fig. 1. Miscellaneous Samples of Cold-heading made on E. J. Manville Machines

headed, are known as cold-headers. It is the purpose of this article to describe briefly the operation of various types of heading machines, to enumerate some of the limitations and possibilities of the different cold-heading machines and to give a general idea of the way in which the tools are planned and made for this class of machinery. No attempt

will be made to cover the heading of hot stock such as is followed in making hot formed bolts, as this type of machinery comes under the head of forging machinery. Fig. 1 shows some cold-headed rivets and screw blanks made on E. J. Manville cold-headers.



Figs. 2, 3 and 4. Illustration of Principles of Cold-heading

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above the surface of the block, as at C, Fig. 3, and strike the end of this piece a square blow with the same hammer, the piece will assume about the appearance indicated at D, in Fig. 3. The projecting section will be bulged as before, but the part of the blank remaining within the block must necessarily retain its original shape, as it is confined in all directions. Continuing our experiments still further, if we

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take a new blank of the same dimensions and insert it in the same block as before, but in place of the flat ended hammer we use one with a cup-shaped depression turned in its face, as shown at *E*, Fig. 4, and strike the blank a hard blow squarely upon the projecting end, the end of the wire will necessarily take on the appearance indicated at *F*, Fig. 4. The blank *must* assume this shape because the part under the head is confined within the lower block and the head section is guided in its bulging by the cup-shaped depression in the hammer with which the blow is struck.

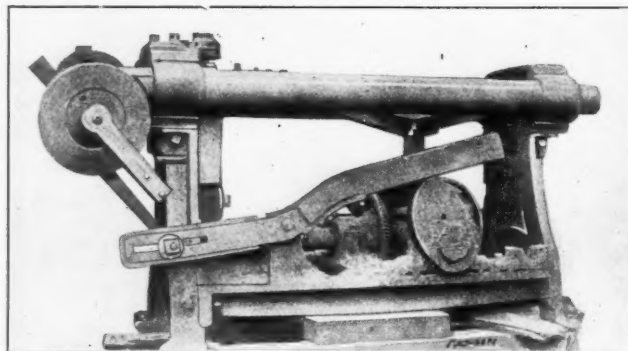


Fig. 5. An Old Type of Header

These three simple experiments outline the principles involved in cold-heading. In all cold-heading operations the blank is confined at the bottom and sides, leaving the metal which is to comprise the head projecting, so that it may be upset and shaped by the punch of the heading machine. In cold-heading, the fundamental point to be remembered is that, under pressure, the wire stock will flow in the direction of the least resistance—always.

#### Early History of Cold-heading Machinery

The use of hand-formed rivets dates back to the ancient Egyptians, but this article must be confined to the machines and tools used for automatically producing rivets and screw blanks. The first instance we find of cold-heading by machinery was in England, about 1760, when two brothers, John and William Wyatt, designed and built a machine for heading wood screw blanks. In America, there is no doubt that Josiah Gilbert Pierson's cold-header, patented March 23, 1794, was the first machine of its kind, although the patents were destroyed when the patent office was burned early in the last century. Pierson's factory was first on the site of the present New York Produce Exchange, but later he moved to Ramapo, N. Y. His heading machine was a massive affair, with a heavy framework anchored to the floor. A large flywheel was provided, and the machine was operated on the now familiar toggle principle. In 1838, the Eagle Screw Co., of Providence, R. I., was started by William G. Angell, and its earliest machine

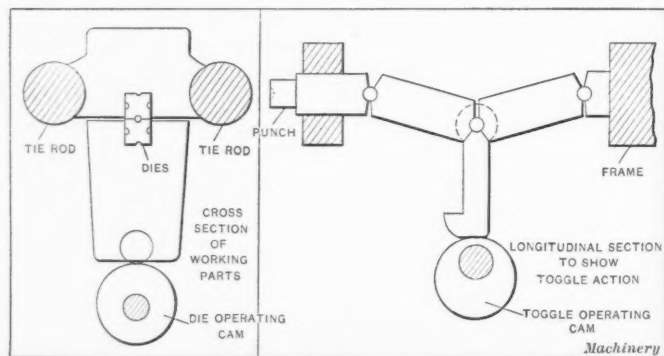


Fig. 6. Diagram illustrating Operation of Header shown in Fig. 5

was what is known to-day as the old Eagle header. At the factory of the American Screw Co., Providence, R. I., this type of machine is used to-day on certain classes of work. Mr. Benjamin Thurston, superintendent of the American Screw Co., states that in the early days of cold-heading each machine was mounted upon the ends of long posts which ran through the floor down to a solid ground foundation.

#### An Old Type of Header

In Fig. 5, is shown one of the earliest cold-heading machines now in existence, and while it has long ago out-lived its use-

fulness, it is interesting to compare it with modern heading machines. This machine was designed by W. E. Ward and built by Russell, Burdsall & Ward, of Port Chester, N. Y., at some time prior to 1856. The line engraving Fig. 6 gives an idea of the general principles upon which this machine operated, from which it will be seen that the operation of the punch was effected by means of toggle mechanism actuated by a cam on the lower shaft of the machine. The vertical cross-section through the dies is indicated at the left. As the machine was of the open-die type, the lower die was actuated by another cam. Two extremely heavy rods extended the length of the sides, as shown in the engraving, Fig. 5, and in section in the illustration, Fig. 6. These served to tie the machine together, enabling it to better withstand the heading operation. The output of this machine, which was used for

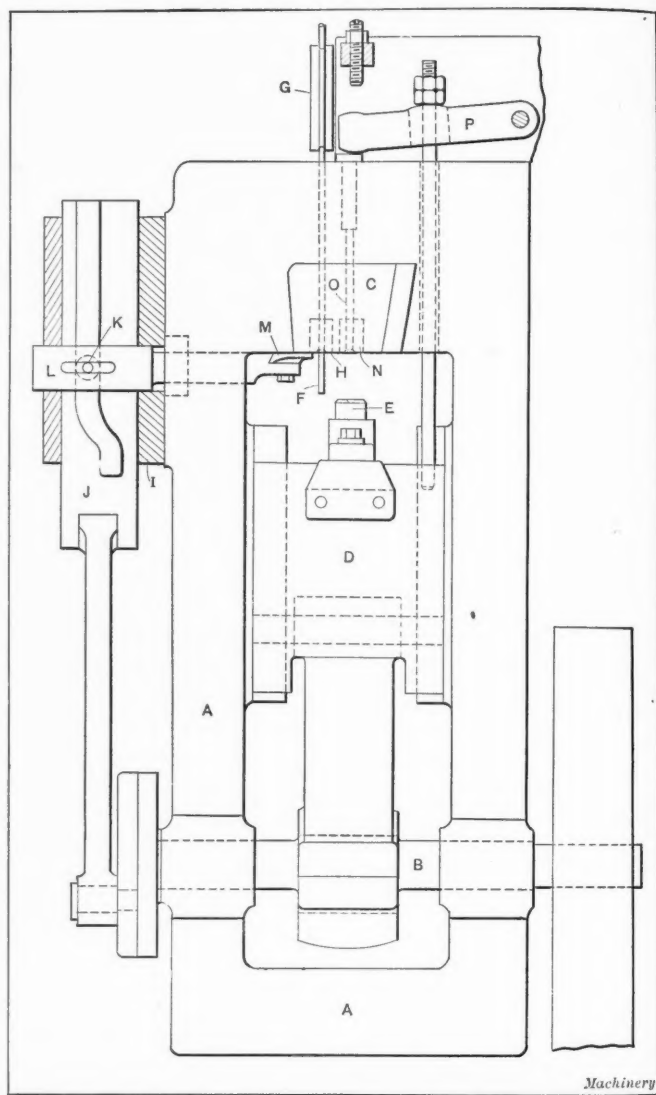


Fig. 7. Plan View of a Modern Cold-header

making stove bolts  $\frac{1}{4}$  to  $\frac{3}{8}$  inch in size, was about 30,000 headed pieces per day of eleven hours.

#### Operating Principle of Modern Heading Machines

Practically all modern heading machines operate upon the same general principle, although there are many modifications and features which each maker considers best. By referring to Fig. 7, which shows the plan view of a modern single-blow solid-die heading machine, it will be seen that there is a heavy framework A, at one end of which is located the driving shaft B, rotated by a driving wheel at the right-hand side; at the other end is located the die-block C. Between the sides of the heavy framework is a movable ram D which serves to actuate the heading punch E. The wire, which is indicated at F, enters the machine through feed rolls G and thence through the framework of the machine, passing through the cut-off quill H. At the left-hand side of the machine is supported the bracket I, in which slide J may be reciprocated by means of a crank motion from the main driving shaft. Slide J con-

tains a cam groove in which roll *K* is fitted, and as roll *K* is mounted upon the cross-slide *L*, it will be seen that a lateral motion is thus imparted to the cut-off knife *M*, located on the end of cutter bar *L*. The ratchet feed advances the wire through the cut-off quill to the feed stop, not shown, after which cut-off knife *M* is advanced in the manner just described, severing the wire, but retaining it on the cut-off blade by means of a spring finger. The advance of the cut-off knife and wire is continued until it reaches a position directly in front of the

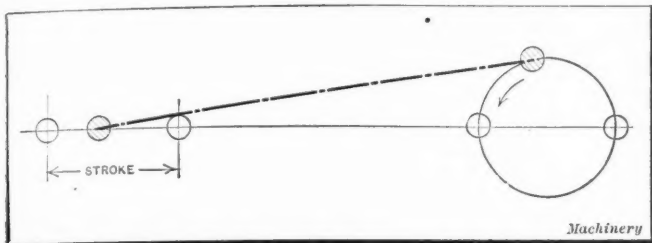


Fig. 8. Diagram to illustrate Operation of Crank Headers

opening in die *N*. At this position it is held stationary long enough for punch *E* to begin to push it into the die, at which time the cut-off knife retreats and allows the punch *E* to continue its work by pushing the blank to the bottom of the die cavity, afterward upsetting the projecting part of the wire to form the head. The wire blank *F*, when pushed into the die, is prevented from passing too far by a backing pin *O*. After the piece has been headed, the backing pin is advanced by ejecting mechanism operated by lever *P*, which receives its motion from a crank on the right side of the machine connected to the main driving shaft. This, briefly stated, is the general principle upon which all modern heading machines of the single-blow solid-die type operate.

#### Crank-operated Headers

There are two distinct principles employed for reciprocating the movable ram of a cold-header. These are the crank principle and the toggle principle. In the machine just described and illustrated in Fig. 7, motion is transmitted to the

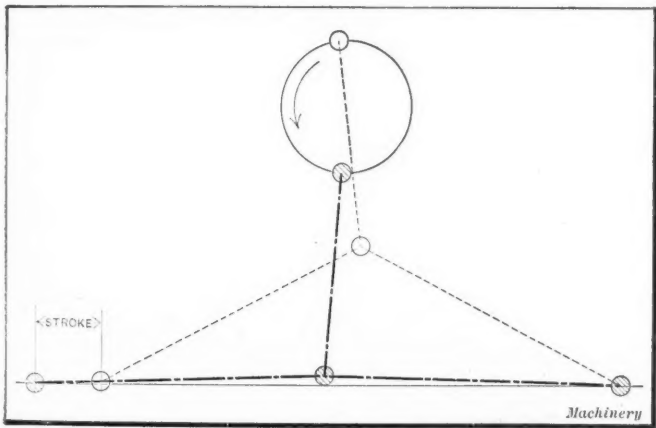


Fig. 9. Diagram to illustrate Operation of Toggle Headers of Two-cycle Type

ram by means of an eccentric upon the driving shaft, the eccentric, of course, being a modification of the crank principle. By referring to the diagram Fig. 8, it will be seen that in the crank-operated header the length of the stroke is equal to the diameter of the crank-pin circle, and that one stroke is accomplished in each revolution of the driving shaft from which the crank is operated.

The crank principle is employed on most single-stroke machines and by one manufacturer for double-stroke machines as well. On double-stroke cold-headers of the crank-operated type, it will be seen that the crankshaft must make two revolutions to secure the two strokes, and these two strokes will be of equal length. The blow secured by the crank-operated header is of a quick punching character rather than a gradual squeezing operation, and exponents of crank-operated headers consider this feature to be of great importance.

#### Toggle-operated Headers

The other principle upon which cold-headers operate is the toggle principle, of which there are several variations. The

common type of toggle action is that shown in Fig. 9, in which the toggle is straightened by a crank-actuated link, which brings the arms of the toggle to a straight line once during each revolution of the crankshaft. This, of course, gives one stroke of the ram to each revolution of the crankshaft, but the blow obtained is of a gradual squeezing character, especially at the ends of the stroke where the greatest amount of work is being done. This type of toggle mechanism is known as the two-cycle type, two revolutions of the crankshaft being necessary to complete a "two-blow" rivet. Another type of toggle operating mechanism which is extensively used on the double-stroke machines is illustrated in Fig. 10, from which it will be seen that two blows are struck at each revolution of the crankshaft which operates the arms of the toggle. As this type of machine makes a two-blow rivet in one revolution, it

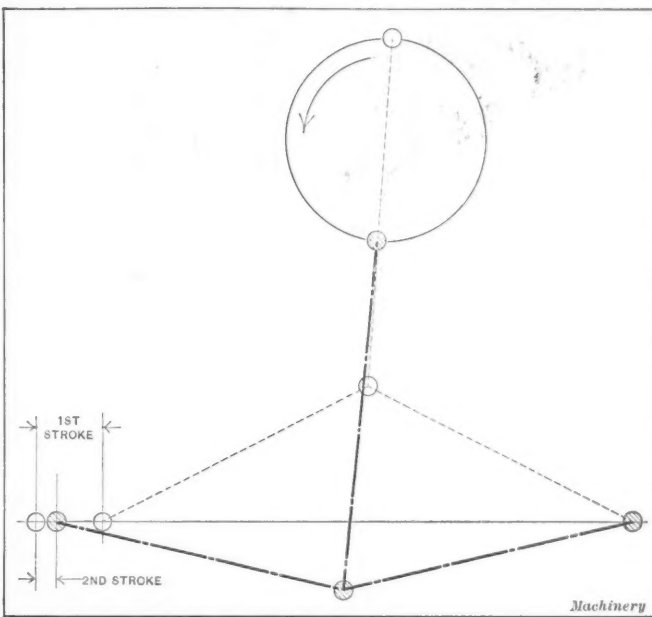


Fig. 10. Diagram to illustrate Operation of Toggle Headers of One-cycle Type

is termed a "one-cycle" machine. The chief difference between the two-cycle type of toggle action and the one-cycle type lies in the fact that in the two-cycle mechanism the toggle is straightened when the extreme of the crank motion is reached, but in the one-cycle mechanism it is straightened midway of the extreme distance of the crank, so that in the latter machine two blows are secured during one revolution of the crankshaft. The two strokes may be of equal length; the first stroke may be the longer, or *vice versa*, by varying the distance between the crankshaft and the line of the straight-

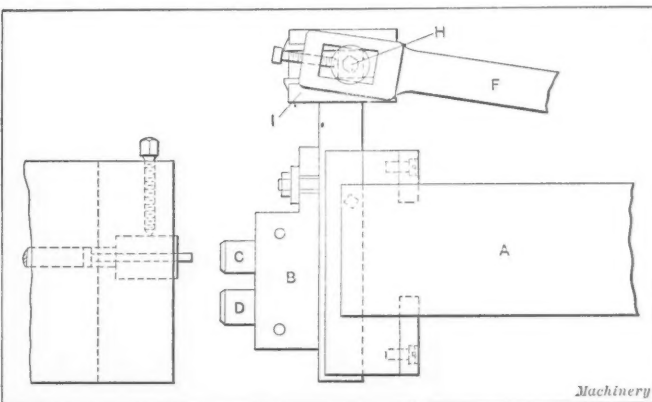


Fig. 11. Mechanism for operating Ingraham Rise-and-fall Motion

ened toggle. In Fig. 10, the first blow is the long blow as the toggle is pushed down to the straightening point. As the toggle is drawn further above the straightening line than it was below, the second blow will be the short one, as indicated.

#### Double-stroke Cold-headers

In describing the header illustrated in Fig. 7, it was stated that this was a single-stroke machine as contrasted with a machine for striking two blows on each piece. A great many

jobs of heading, however, cannot be adequately handled on a single-stroke machine, as there is too much metal to be upset in the head. When the amount of metal to be put into the head exceeds two and one half diameters of the wire in length, it is necessary to employ a double-stroke machine. The double-stroke machine operates in practically the same way as that

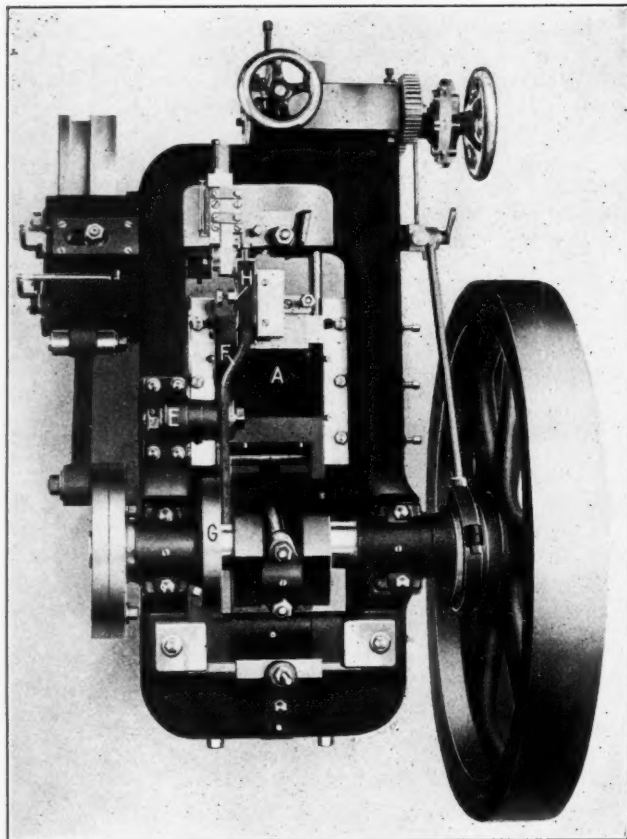


Fig. 12. Plan View of Blake & Johnson Double-stroke Solid-die Header

shown in Fig. 7, except that it strikes two blows in rapid succession upon the wire blank before it is ejected. The preliminary blow is known as the coning blow; in this the wire is partly upset and prepared for the second blow which finishes the head. The two punches are "slidably" held on the ram, and the mechanism for changing the positions of the dies for the two blows is called the rise-and-fall motion. While there are several different means of securing this motion, the Ingraham rise-and-fall motion used on Blake & Johnson cold-headers is typical. By referring to the line illustration Fig. 11, which shows a side elevation of the principal parts, in connection with the halftone illustrations Figs. 12 and 13, the operation of this device can be readily followed. Upon the end of ram A, the die-holding slide B is secured. This slide is free to move vertically so that upper punch C or lower punch D may be operated in alignment with the stationary die. In Figs. 12 and 13, these dies are not shown. Pivoted upon bracket E, which is bolted to the left side of the frame, as shown in Figs. 12 and 13, is the lever F which controls the rise-and-fall movement of the punch slide. This lever is actuated by a cam upon the driving shaft of the machine, as indicated at G, Figs. 12 and 13. At the opposite end of lever F, a bearing pin H is adjustably mounted, being free to slide in the ways provided in section I of the punch-holding slide.

Thus by having cam G of the proper shape, the rise and fall of punch-holding slide B may be so timed that at the time of the position of the first blow, punch C will be in line with the die, and at the time of the position of the second blow, punch D will be in line with the die. It is obvious that on double-stroke machines, the wire feeding, cut-off and ejecting mechanism must be geared to agree with every second stroke of the ram.

#### Triple-stroke Headers and Reheaders

In addition to single- and double-stroke machines, triple-stroke headers are sometimes used where the amount of metal to be displaced is more than can be effected with two blows. Triple-stroke headers are similar in action to other headers, except that three blows are struck. Two blows, however, will usually upset the metal of most heads to a point of crystallization so that except in special instances the use of a third blow would be of no advantage, because the blanks would require annealing before a third blow could be struck. Many heading jobs require two distinct operations to perform the work, usually on account of the shape of the pieces. For this purpose the work is carried as far as possible with an ordinary single- or double-stroke header, after which the pieces are annealed and completed in a reheader. By means of an automatic hopper feed, the partly formed pieces are placed in the heading dies and the subsequent operations performed. Reheaders are made which strike one, two or three blows.

#### Open-die Machines

Thus far we have only described single- and double-stroke machines of the solid-die type, but for handling work in which the length of the pieces under the head exceeds nine or ten diameters of the wire, it is necessary to employ dies which open longitudinally to make ejection of the work possible. The heading operation upsets the metal of the blank for its entire length in addition to the upsetting of the head, so that the metal of the shank is squeezed out against the sides of the die. In the case of a solid die this upsetting of the metal in the shank makes the resistance to ejection too much when the work has a long shank.

Cold-headers employing open dies require die-operating mechanism of an entirely different character from that which is used in solid-die machines. By referring to Figs. 14 and 15, the operation of the dies of a machine of this type may be followed. Referring to Fig. 14, the framework of the

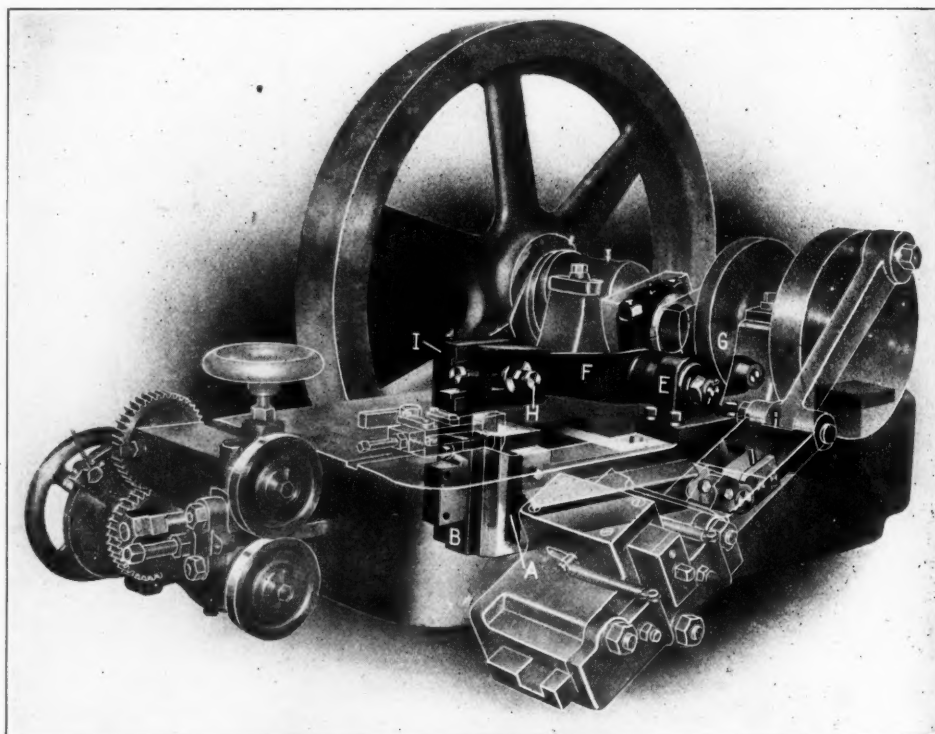


Fig. 13. Phantom View to illustrate Operation of Ingraham Rise-and-fall Motion

header is shown at A, the ram at B, and the punch at C. The two halves which constitute the dies are shown at D and E. The wire, which is indicated at F, runs through straightening rolls of the usual type, through the framework of the machine.

as well as the die-holding block, and thence through the dies themselves. In feeding, the wire is run out against a stop, not shown, and is cut off by the movement of the two halves of the die in unison toward the right, which also brings the wire blank over into line with the heading punch *C*. Different makers of cold-headers use different methods for moving the die-blocks, and one of these constructions is here illustrated. The action of this mechanism is best shown by the sectional view in Fig. 14. A flat cam *G* is reciprocated by a crank connection to the driving shaft of the machine. When this flat cam is pushed in, it raises the toggle of which arms *H* and *I* are members. This action tends to straighten another toggle composed of arms *J* and *K*, and in straightening the latter toggle, slide *L* is made to push die-halves *D* and *E* laterally, thus severing the wire and moving it into the heading position. A spring pin *M* assists in returning the toggle mechanism for another operation. By referring to the sectional illus-

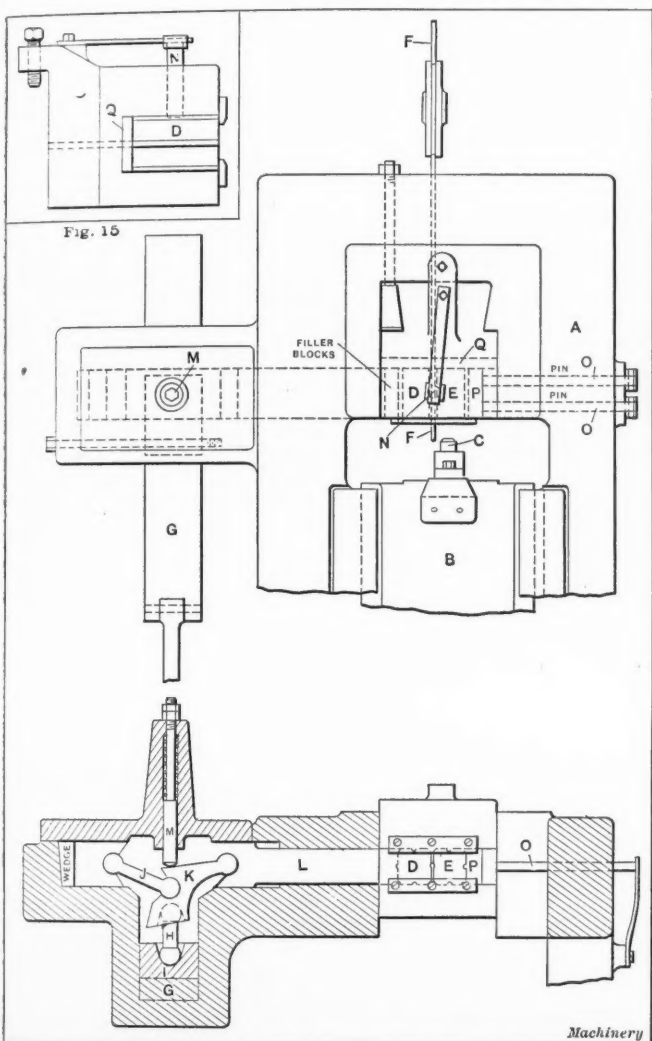


Fig. 14. Construction of Die-operating Mechanism for Oper-die Headers.  
Fig. 15. Side Elevation of Dies and Spring Pin

tration, it will be seen that the corners of the two halves of the die are chamfered. A wedge pin *N*, more clearly shown in the smaller illustration, Fig. 15, fits into this chamfered opening at the parting line, and by means of a flat spring which presses downward upon the wedge pin, it tends to force the dies apart whenever lateral pressure is removed. This, of course, facilitates the ejection of the headed piece, which takes place when the new length of wire comes forward. Similarly, two spring pins *O* are provided which press against a filler block *P* on the opposite side from the die-operating plunger *L*. These serve to return the dies to the cut-off position after the piece has been headed.

In the heading position the rear end of the wire blank is backed up by backing plate *Q*, which is of hardened steel, so that the rivet or screw blank is effectively contained while being headed. From this construction it will be seen that the length of the dies must be the exact length of a headed rivet or screw blank measured under the head.

## PUNCH AND DIE FOR FORMING ELECTRIC TERMINALS

BY ARTHUR L. SENESAC\*

The illustrations presented herewith show a useful form of punch and die for forming electric terminals of the type shown in Fig. 1. The stock from which these terminals are

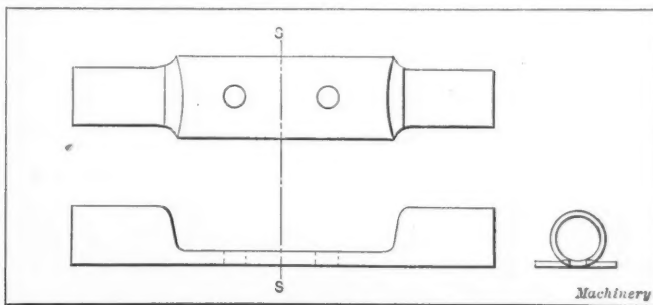


Fig. 1. Electric Terminal formed in the Punch and Die

made consists of copper tubing which is cut into blanks of the proper length to fit into the feeding chute shown in the illustrations of the punch and die. The blanks are fed into the

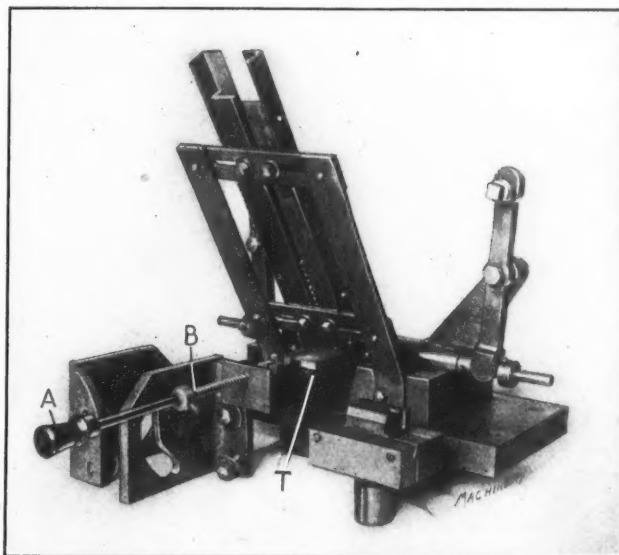


Fig. 2. Front View of Die showing Feeding Mechanism

die by means of the handle *A*, Fig. 2. When this handle is pushed forward, it carries with it the block *T*; block *T* pushes a blank under the spring clips *W*, Fig. 3, when it moves for-

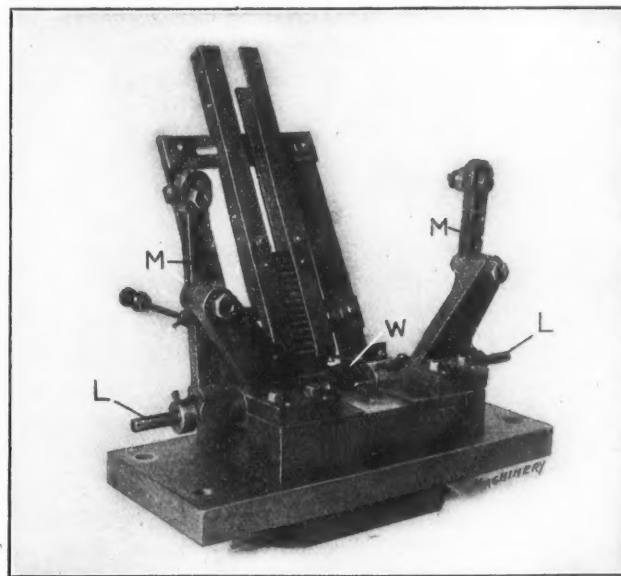


Fig. 3. Rear View of Die showing Clip for holding Blanks in Chute

ward. An extension on the block *T* pushes the piece finished by the preceding stroke out of the die. The handle *A* and the feeding slide are returned to their original position by the

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tension of the spring *B*. When the press is tripped, the cam-actuated levers *M* bring the pins *L* into the ends of the blanks to prevent them from being flattened out. The punch forms the work and pierces the two holes in the flattened section in one operation. The pieces are then cut along the line *S-S* so that two terminals are produced for each stroke of the press.

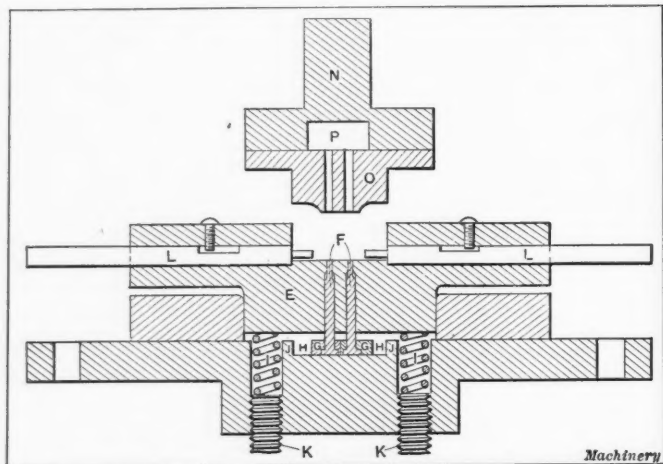


Fig. 4. Cross-sectional View showing Construction of Punch and Die

The construction of the punch and die will be understood by referring to Fig. 4. The punch-plate *E* is held up by the two springs *I* until the blank is nearly formed. Additional pressure of the punch forces the punch-plate down, and the two piercing punches *F* project sufficiently to pierce the holes in the work. When the punch rises, the pins *L* are drawn out

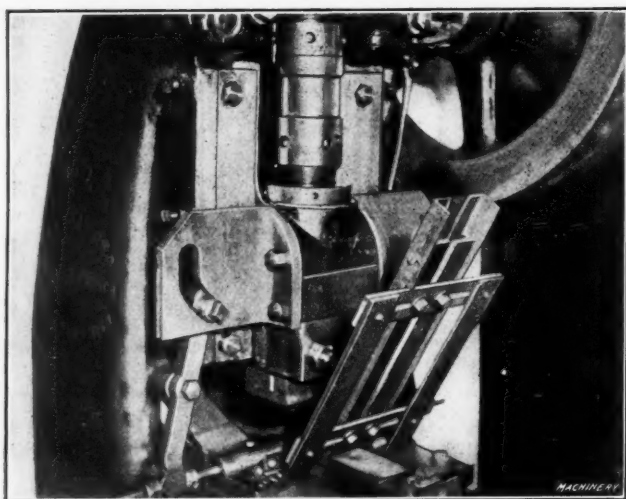


Fig. 5. The Punch and Die set up in a Press

from the ends of the work and the punch-plate *E* is then raised by the tension of the springs *I* until it engages a stop. The punch-plate thus strips the work from the punches. The two screws *K* are used to adjust the tension of the springs *I*. The punch-holder, which is shown at *N*, is dovetailed to receive the punch *O*.

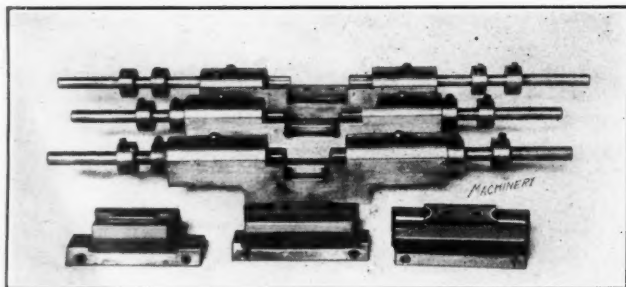


Fig. 6. Punches and Punch-plates for making Different sized Terminals

The electric terminals made in this punch and die are of several sizes, and the same equipment has been adapted to different sizes of work by simply providing different punch-plates *E* and corresponding punches *O*. When it is required to change from one size of work to another, the punch-plates are

changed, the blocks *G* which carry the punches *F* being moved sufficiently to allow the punches to be entered into the new punch-plate. The new punch *O* which corresponds to the new punch-plate *E* is then mounted in the punch-holder *N*. This provision for changing the punch and punch-plate has been the means of materially reducing the cost of the equipment, as the other parts are available for the production of all sizes of terminals.

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### FOREIGN EXHIBITIONS

A number of foreign exhibitions of some importance will be held during the next two years. In May of this year the Ghent (Belgium) World's Fair will be opened and will remain open until late in the fall. This exhibition bids fair to exceed, both in extent and importance, all preceding exhibitions held in Belgium, including the World's Fair at Brussels in 1910. The Hall of Machinery covers an area of over 200,000 square feet and will contain exhibitions from practically all industrial countries in the world.

At Malmö (Sweden), what is known as the Baltic Exposition will be held in 1914. The principal countries that will exhibit there will be Russia, Germany, Denmark and Sweden. The exposition will be opened May 15, 1914, and will be open until September 30. Applications for space will be received until May 31, 1913, and should be addressed to "Styrelsen for Baltiska Utställningen, Malmö, Sweden." The directors of the exhibition state that they cannot say in advance whether exhibits of manufactures other than from the four countries mentioned will be received, but they will accept applications for consideration. The exposition is to be of an industrial and general character, including all classes of machinery.

A National Exposition will be held at Berne, Switzerland, in 1914. Especial attention has been given to the machinery section, in which machinery of all classes manufactured in Switzerland will be exhibited. Prominent manufacturers of electric dynamos and turbines have reserved a large amount of space. The Machinery Hall will be the principal building of the exposition, and will contain the most complete exhibit of Swiss machinery ever made.

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A large New England screw manufacturer, part of whose product is rolled thread screws, also makes bow micrometers, chiefly for use of wire drawers, sheet rollers, etc., as a small side line. These micrometers are not highly finished but are accurate, and being low-priced are well suited for the users. The screw threads of the micrometer spindles are rolled. No claim is made for superior accuracy over chased threads, but it is asserted that rolled screw threads are of very uniform pitch. Given a lot, say of one hundred rolled thread screw micrometers, they all might vary slightly from the exact pitch of forty threads to the inch, but the inaccuracy of all would be practically identical. Hence, in making up a lot of micrometers, the datum line is scribed out of parallel with the axis of the barrel the same amount for all of the one hundred micrometers. Many mechanics probably are not aware of the fact that some micrometer makers regularly adjust the datum line to the peculiarities of each instrument. If the screw is out of pitch, the datum line is set accordingly to compensate for inaccuracy of pitch one way or the other, according to whether it is long or short in the lead. The manufacturer of rolled thread screw micrometers need make only one adjustment of the machine for cutting the datum line for the whole lot that is being put through.

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A marked change in the attitude of machinery manufacturers to the training of mechanics has developed within the past few years owing to the difficulty of hiring men having had general experience which fits them to do a variety of work. The great majority of men applying for employment are specialists trained to run a drilling machine, lathe, planer or other machine and having little skill for any other work. It has become practically necessary to train apprentices to work on a variety of machines and at the bench, and to pay them good wages while learning in order to have all-around workmen sufficient to fill the necessary positions.

## FREE-HAND SKETCHING IN MECHANICAL WORK

VALUE OF SKETCHES—APPLICATION IN A FILING SYSTEM—FAULTS OF SKETCHES—PERSPECTIVE

BY ALBERT A. DOWD\*

Free-hand sketching, as applied to the mechanical arts, is not taught in technical schools or colleges, yet it is used an incalculable number of times each day in every factory in this country. We may ask why more attention is not paid to this valuable art in our institutions of learning, and the reply comes, "It is a natural gift and something which cannot be taught to everyone, because one man has the knack of hand-

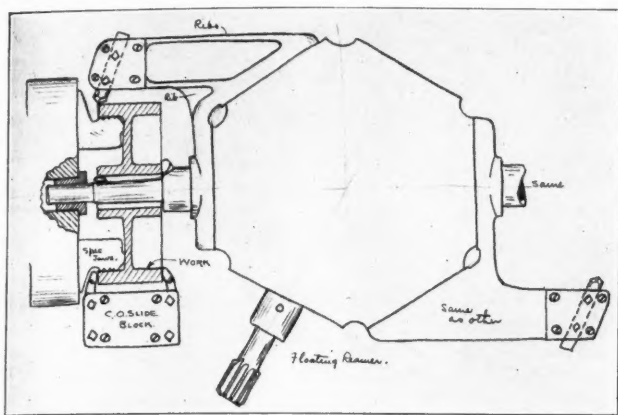


Fig. 1. Free-hand Sketch showing Tooling for a Turret Lathe Job

ling his pencil more cleverly than another, and has a better sense of proportion." Let us acknowledge that the latter part of this is true, as we must also admit that one man is a better mechanic than another because he seems to have the mechanical gift "born in him." There are, however, thousands of good mechanics throughout the country, not blessed with this gift, who have acquired their knowledge by good hard work, a patient application to detail and, above all, an unconquerable spirit combined with the will to succeed in whatever they may undertake. Why, then, may this not be applicable to other things, as, for instance, the free-hand sketching of me-

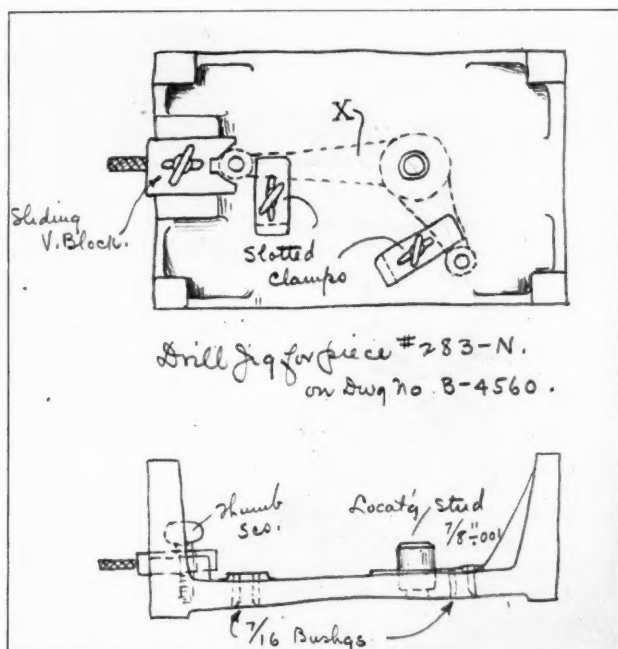


Fig. 2. Sketch of a Simple Drill Jig for a Bell-crank

chanical things? I firmly believe, judging from my own experience, that ability may be acquired in free-hand sketching if a little time is devoted to the subject, and I hope the time may not be far distant when the technical schools of this country will realize its importance and lay more stress upon it in their curriculum.

I think there are very few persons who will dispute the statement that a mechanical free-hand sketch, well proportioned and clearly made, shows an object far more legibly

than a mechanical drawing of the same piece. By this I simply mean to imply that it is more easily understood at a glance. There are several reasons for this. For example, in making a sketch, a person naturally exaggerates the particular points to which he wishes to draw special attention. This exaggeration may take the form of a slightly heavier outline, or it may be that the portion mentioned is more carefully delineated. At any rate we all know how easy it is to see exactly what a man is driving at when he makes a free-hand sketch before our eyes. Another reason is that a sketch contains only the particular portion which is necessary to a clearer understanding of the subject, and leaves out all other lines which tend to make a mechanical drawing more complicated and difficult to read at a glance. Note the difference in the sketches which two men make. One makes a scrawly, ill-proportioned object, which looks as if the lines might terminate anywhere and has no character whatever, being of the

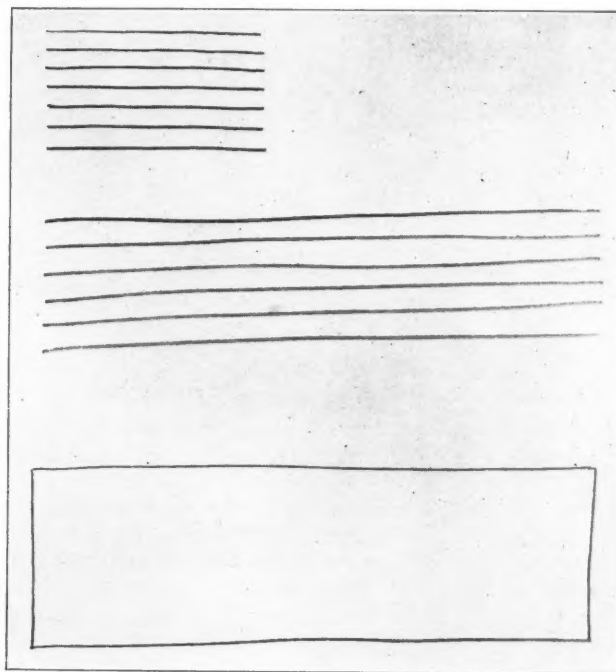


Fig. 3. Preliminary Exercises in Free-hand Sketching

same neutral tint all over. The other man sketches the same subject, and his lines are clear (not perfectly straight perhaps, but having a good general sense of direction) his proportions are good, and there is a sort of "snap" to the entire sketch so that it stands out boldly on the paper. You would immediately know, without a second glance, that this man knows exactly what he wants and has shown it in the fewest possible lines.

The prime object of this article is to call attention to the rather neglected art of sketching as applied to mechanics, to point out the more common faults and to suggest methods of improvement which will assist one in becoming more proficient. We all know how frequently sketches are used for all sorts of purposes in the shop; they are often made hastily by the superintendent, chief draftsman, foreman or workman, and in many instances they are used as a guide in making a piece of work. Oftentimes a workman in the shop, endeavoring to explain a machining operation, will take his pencil and sketch out the object of which he is speaking on the back of a time card. This sketch is usually very crude, yet it seldom fails to explain his meaning, although he will usually apologize for it, saying, "It looks something like this but I can't make a sketch." This man is very possibly a skilled mechanic, who can produce a piece of work requiring extreme accuracy in a satisfactory manner, and yet lack of practice makes him unable to give weight to his remarks by means of a pencil sketch.

\*Address: 84 Washington Terrace, Bridgeport, Conn.

### Value of Sketches

In laying out an equipment of tools for almost any kind of work the free-hand sketch plays an important part. For example, in turret lathe tool design a sketch is almost invariably made of the holding device, whether it be a fixture or special chuck jaws. The turret is then shown with its four, five or six faces (as the case may be) and the desired cutting tools in position on their respective turret faces. The cross-slide is also shown, carrying its proper quota of tools, and several sketches are quite frequently made before the best method of handling the work is determined. An example of this kind is shown in Fig. 1. I have found a piece of cardboard layed off with  $\frac{1}{4}$ -inch squares of great assistance for this kind of work, where correctly proportioned sketches are essential. A piece of tracing paper may be tacked down on it and proportional sketches made quite rapidly. Sufficient in-

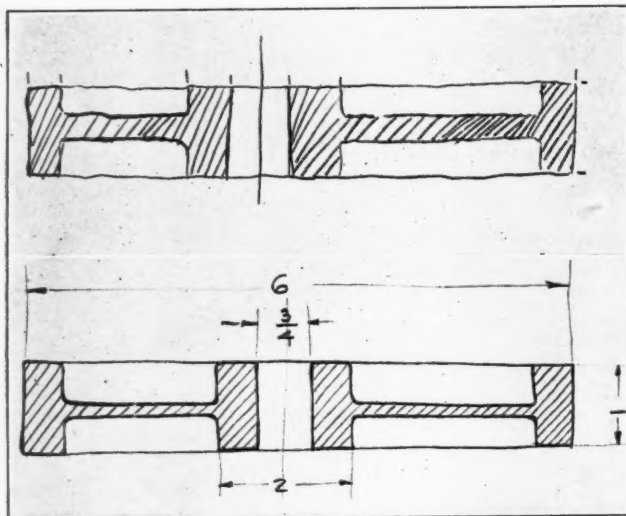


Fig. 4. Poor and Well Drawn Sketches of a Gear Blank

formation may be put on a sketch of this kind in a very short time, to enable a tool designer to lay out all the cutting tools required for the job.

The jig and fixture man could hardly exist without his pencil and paper, but he would find it a great advantage to sketch in the object upon which the work is to be performed, with a red or blue pencil, before proceeding with the design, bearing the approximate proportions in mind. With this sketch as a basis, the adjacent parts of a jig or fixture can be made to adapt themselves more readily to existing condi-

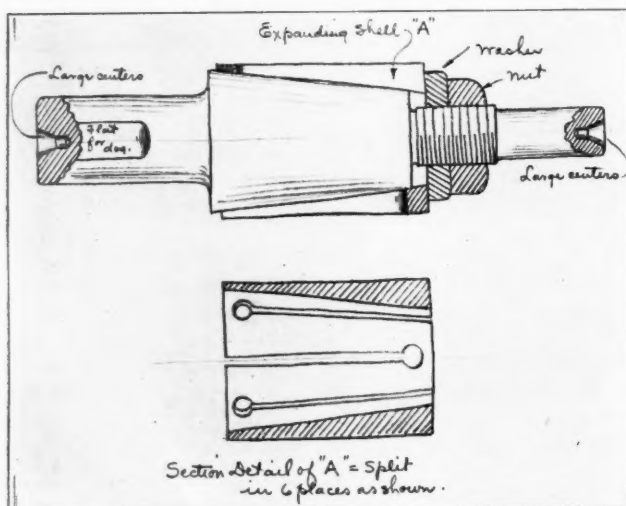


Fig. 5. Sketch of Expanding Arbor that gives Good Practice in Free-hand Drawing

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An important field of usefulness for the free-hand sketch is found in connection with methods used in filing jigs, fix-

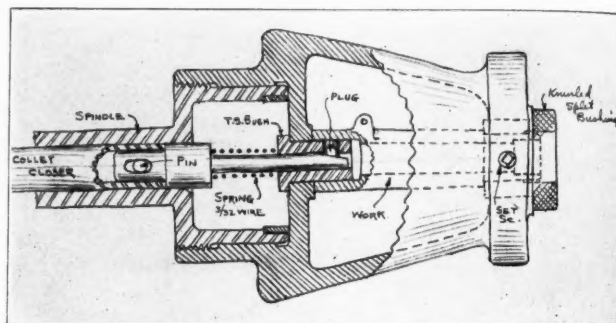


Fig. 6. Sketch showing Partial Sectional View making more than One Illustration Unnecessary

tures, cutting tools, etc. If a card system is used the back of the card may very easily contain a small sketch of the object referred to, with a couple of dimensions indicating its size. This will be found much more convenient than a reference to the original drawing, which may be filed in a way that makes it somewhat inconvenient to obtain it at a moment's notice. This method enables the jig and tool man to pick out exactly the tool he wants on a certain piece of work, although that particular job may embrace fifteen or twenty different fixtures. A record of this kind may be made more rapidly than one would think, as in filing by the card system

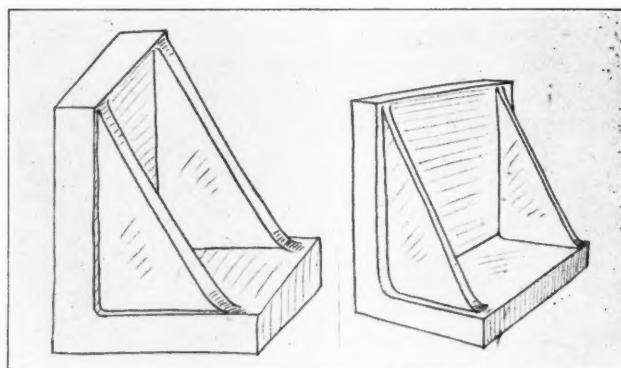


Fig. 7. Examples of Distorted and Well Drawn Perspective Sketches

it is necessary to have the drawing at one's elbow, so that a couple of minutes should suffice to make a rough outline which is sufficient to explain the purpose of the fixture.

### Sketches Preserved for Future Reference

There is another point, of which I have made no mention, and that is the value of sketches preserved for future reference. How many mechanical men are there with experience which runs back a number of years, who have not wished they could remember the details of some special machine or method for doing a certain piece of work? I have in my possession old sketches and drawings which I have preserved for nearly fifteen years, and while these are in many cases out-of-date, something occasionally comes up where a reference to them is extremely convenient. Naturally, the sketches of more recent date are of much greater value, but the older ones are still kept, partly, perhaps, because they are "in good company." I suggest to any man engaged in mechanical pursuits, that the habit of keeping sketches for convenient reference (either in a book or loose in an envelope) will amply pay for the slight trouble which it may involve. Incidentally, I have found it a very good plan to put a date on the sketch, in addition to any data which may seem desirable. While speaking of this matter, I must mention a very successful designer and foreman of my acquaintance, who does not attempt to file

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Sketches of rectangular work are seldom anywhere near rectangular. Right angles are either acute or obtuse. Curves are not symmetrical. The sketch frequently has no "character," and by that I mean that the lines are all about the same weight, no part standing out beyond another due to a heavier line or a bolder stroke of the pencil. Perhaps the greatest fault of all, and the one which is most common, is the loss of correct proportion in the object delineated.

#### Suggestions for Practice with a Few Helpful Hints

One of the important points which is, perhaps, the basis of the whole art, is the ability to draw an approximately straight line. Consequently the beginner should spend a little time in making parallel lines about two inches long (see Fig. 3), keeping them as nearly the same distance apart as possible. Continue this exercise until able to make lines five or six inches long which look like straight lines and not like the waves of the ocean. Having mastered this, proceed to make two parallel lines about two inches apart and six inches long, connecting

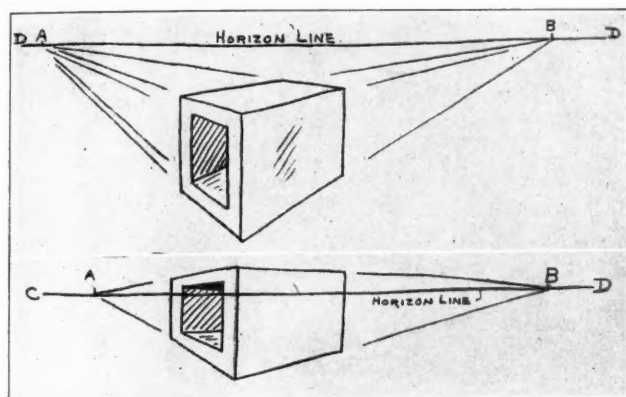


Fig. 8. Sketches made from Above and Level with the Horizon Line

the ends with two perpendiculars and thus forming a rectilinear figure as shown in the lower portion of Fig. 3.

After gaining confidence in the use of the pencil, proceed to make a gear blank 6 inches diameter by 1 inch face, having a  $\frac{3}{4}$ -inch hole through a 2-inch hub. First draw two parallel lines one inch apart and six inches long, connecting the ends by perpendiculars. Keep the correct proportions of the object constantly in mind and tick off the approximate sizes of the hub and hole with a pencil before drawing them in. Now try a scale on the sketch and see how nearly right it is. Very likely the first attempt will bear a close resemblance to the upper sketch in Fig. 4, but if drawn with more regard for the true proportions, it should more nearly approximate the result shown by the lower illustration. If the sketch is found to be badly out of scale it should be re-drawn until satisfactory; then put on the necessary dimensions, and a few light lines indicating a section. Keep these section lines about parallel and bear in mind that the outline is the principal part, the sectioning being merely to make the outline more prominent. Make your arrow heads and figures boldly and your dimension lines lightly.

After practicing on a few simple things of this nature, attempt a construction drawing of a cylindrical piece having three or more parts as, for example, the expanding arbor shown in Fig. 5. In this particular case, it might be necessary to show more than one view to make the sketch perfectly clear, as the expanding shell A must obviously be split in order to allow it to expand. This shell may be shown as a separate piece removed from the arbor (which is usually the better way) or somewhat less clearly in an end view.

However, this end view involves drawing circles, which is by no means easy. As far as is consistent, it is well to avoid the use of circles, as they are invariably lop-sided, elliptical, or otherwise distorted, unless drawn with a compass. When absolutely unavoidable a circle may be approximated by means of a series of quarter-arcs drawn one at a time with the ends touching, using center lines crossing each other at right-angles as a guide. When making a sketch to be used as a working drawing, all unnecessary shading should be avoided, only enough being used to make matters perfectly clear.

#### Value of Sectional Drawings

Sectional drawings are of value where cylindrical objects are to be represented. If a sectional view is used it is seldom

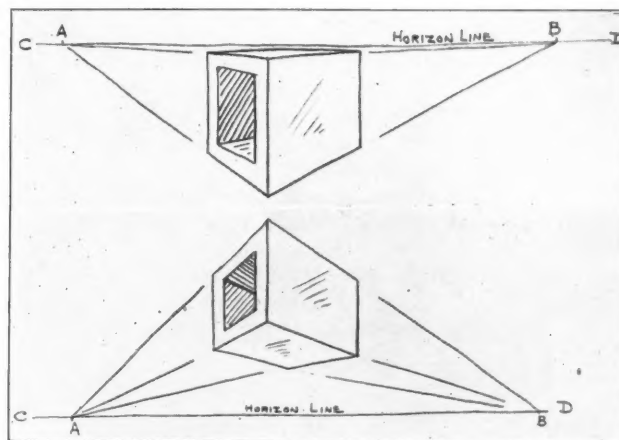


Fig. 9. Sketches made from Different Distances below the Horizon Line

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In order to bring out the full value of a free-hand drawing and make it more comprehensive, a certain amount of shading is sometimes an advantage. For instance, one surface standing out in advance of another may be left plain, and by the addition of a few shade lines at its junction with the remainder of the fixture will throw that surface into bold relief, as shown in Fig. 2. Shading must not be carried to excess, however, and need not be used at all unless it is a

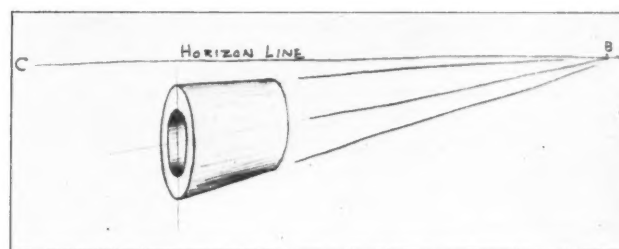


Fig. 10. Sketch of Cylindrical Piece showing Concentric Circles Drawn Free-hand

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It is frequently desirable to break away some portion of a cylindrical object in order to show the interior construction more clearly and, at the same time, to give a general idea of its appearance as a whole. An example of this sort is shown in Fig. 6, and a broken section of this kind sometimes makes it unnecessary to draw in another view. The same method was followed in Fig. 5, where the ends of the arbor are broken away in order to show the prominent centers. In all cases where sections are used, considerable care should be taken to keep the portions on each side of the center line as nearly alike as possible; otherwise, when the sketch is completed, it will present a lop-sided appearance, very detrimental to the general effect.

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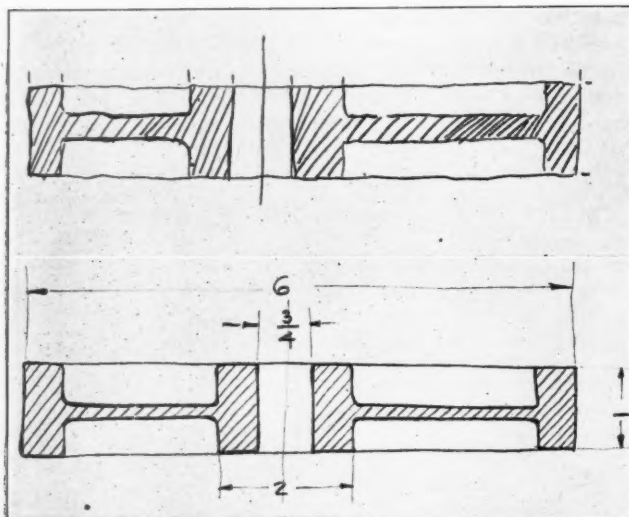


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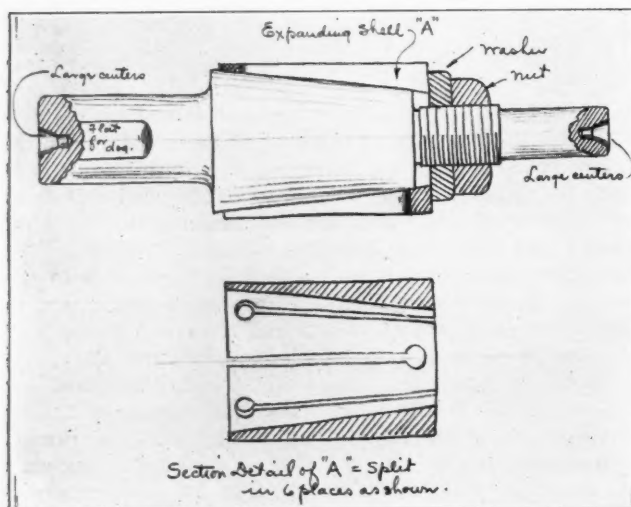


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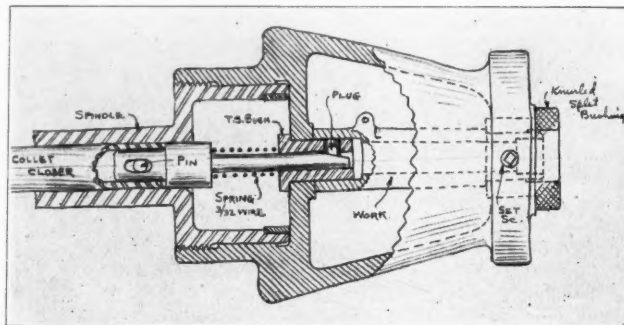


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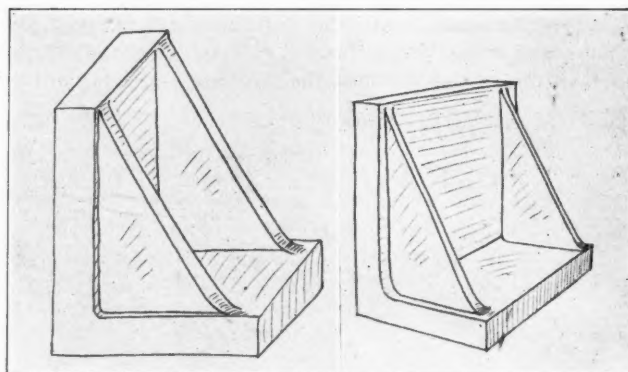


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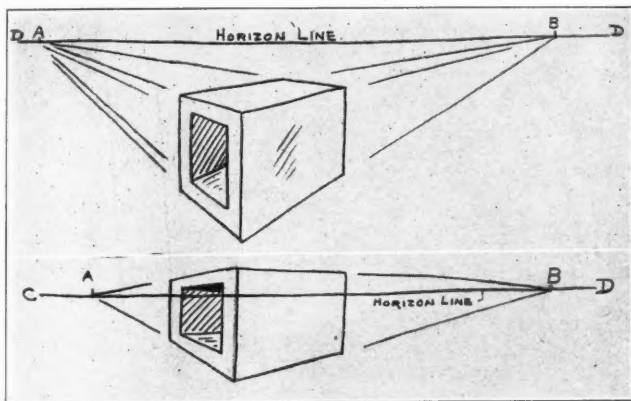


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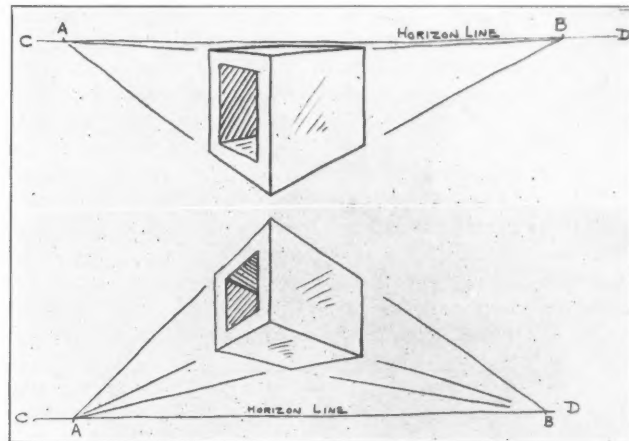


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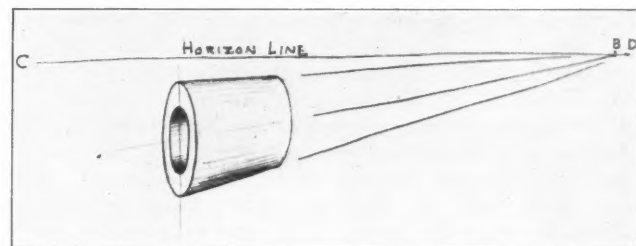


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#### Free-hand Perspective Drawings

After a man has become proficient he may, in certain cases, use the perspective form in sketching, but this should not be done unless he has a good eye for proportion and some

knowledge of the principles involved. Where these qualifications are lacking, the result may be a frightfully distorted view, such as the one shown at the left-hand side of Fig. 7. This sketch, if drawn with more regard to the rules governing perspective, would have the appearance of the right-hand illustration in Fig. 7. Obviously, the subject of perspective is too extensive to handle thoroughly in an article of this kind and, furthermore, its field of usefulness in a mechanical way is somewhat limited, so that I shall simply give a few suggestions regarding the application of its principles.

In a perspective drawing, all vertical lines are shown vertically, but of varying heights which depend upon the ratio of distance from the eye of the observer to the lines in question. Parallel lines in any other plane except the vertical must be so drawn that all lines in such planes will meet in common points, if sufficiently prolonged, as shown at A or B in Figs. 8, 9 and 10. This point is termed the "vanishing point" and when the lines are in a horizontal plane, it invariably falls somewhere on the line C—D, or the "horizon line" as it is called, which is assumed to be on a level with the eye of the observer. The position of the horizon line and the location of the vanishing point determine the appearance of the object shown in the sketch. For example, compare the upper illustrations in Fig. 8 and Fig. 9. These are obviously different views of the same object, the former being seen from a point considerably above and the latter very nearly on a level with the eyes. It will be noted that the view represented in Fig. 9

is by no means perfect, it was drawn without the aid of any mechanical devices, straightedges or other instruments. Nothing was used to obtain the proportions except the eye, and every line in it was made absolutely free-hand. In conclusion, I will urge those sufficiently interested in the matter to try their hand at sketching, as a pastime if for no other purpose, and they may rest assured that in this case, as in all others, "practice makes perfect." In addition to this, the man who perseveres will find himself amply repaid for the effort, both at present and in his future work.

\* \* \*

#### FULL WEIGHT PIPE

The National Tube Co. and other concerns manufacturing welded pipe have announced that the manufacture of the so-called "merchant" weight pipe will be abandoned, and that hereafter only full-weight pipe suitable for all purposes will be furnished. The announcement is of considerable importance to every mechanical trade, and the reason for the change, no doubt, will be of general interest.

In the past, there have been legitimate uses for "merchant" pipe, that is, pipe lighter than the standard pipe, but its use made it necessary for jobbers to keep several grades of pipe in stock, and consumers were more or less uncertain as to what grade of pipe was furnished to fill their orders. Full-weight pipe is suitable for all purposes for which the "merchant" weight pipe has been commonly used,

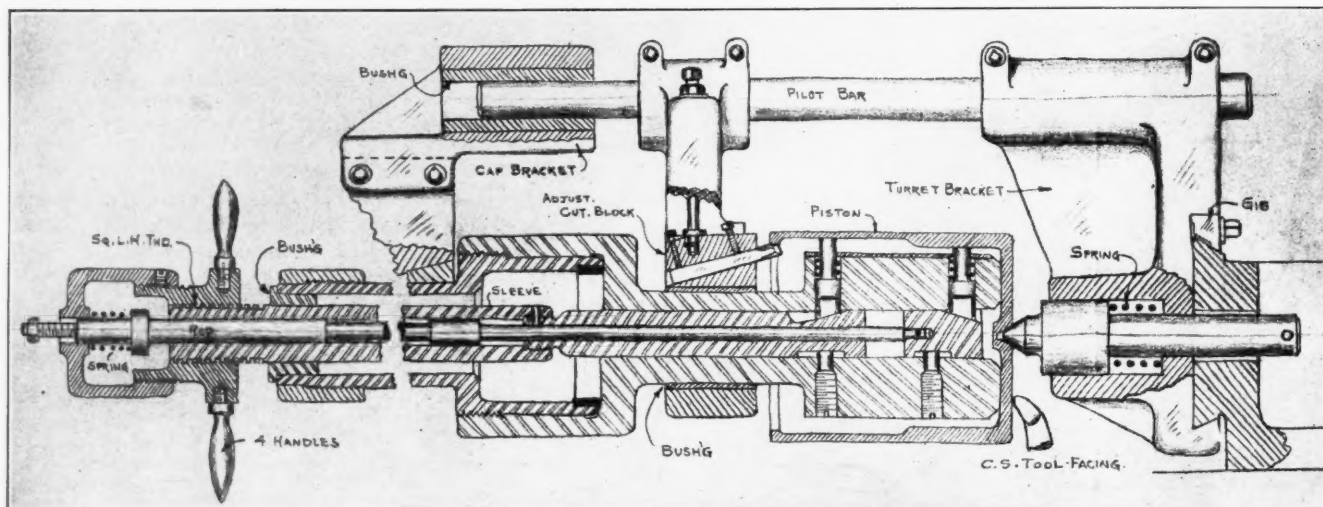


Fig. 11. Example of Proficiency which may be attained in Free-hand Sketching

appears more natural and in better proportion than the one in Fig. 8. This is due to the lower position of the horizon line and the resulting increase of the distance between the vanishing points. Bear in mind, in this connection, that the higher you place the horizon line, the closer together the vanishing points will be, and the less pleasing the resulting drawing will be to the eye. This is due to the fact that the viewpoint taken is a somewhat unnatural one, and for that reason the resulting sketch appears distorted and out of proportion. By carrying the horizon line still lower we note that the upper surfaces do not appear at all, as the edges are hidden by the projection of the two upper lines, as shown in the lower view in Fig. 8. Once more dropping the position of the horizon line, until it is entirely below the object, makes the latter appear as if suspended in the air, as shown in the lower view in Fig. 9.

I have included but one view of a cylindrical piece in Fig. 10, which is presented to show the appearance of circles when drawn in perspective. It is extremely difficult to make a drawing requiring the delineation of concentric circles, and yet not offend the eye by the representation of ellipses which cannot by any stretch of the imagination be considered as anything more than irregular curves. It will be noted that nearly all of the sketches shown are extremely simple, for it is not the writer's purpose to point out how difficult but rather how easy it is to make free-hand drawings of simple objects, after a little practice with the pencil along the lines I have mentioned.

One other example, serving to show the chance for development in sketching, is reproduced in Fig. 11. While this sketch

but the opposite is not true. Serious mistakes have been made and fraudulent impositions have been practiced by the use of "merchant" weight pipe where standard pipe should have been used, and the advantage of the abandonment of its manufacture is obvious. Consumers will be furnished henceforth only with standard pipe for all purposes. The necessity of weighing or measuring to determine whether or not the standard pipe is furnished, will be obviated.

\* \* \*

The power transmission chains made by the Whitney Mfg. Co., Hartford, Conn., are "jacked" before shipment. The "jacking" consists of running them one hour under load, the load being proportioned to the chain capacity. When the production of finished chains runs up into the hundreds per day, the matter of power consumption becomes a serious one. The company has solved the problem very simply and effectively. The same load is made to test several chains running in series. A number of ball bearing shafts and sprockets are mounted on a bed-plate with provision for adjusting them to different center distances. An electric motor drives the first chain which, in turn, drives the first spindle, and that transmits the motion to the opposite spindle and sprockets, and so on back and forth to the fan which provides the load. The load is slightly more on the first chain than on the last, of course, but the difference is only that due to the power absorbed in friction of the chain sprockets and bearings. This loss with "silent" chains and ball bearing spindles, is so low as to be negligible for the purpose of a running test.

## SETTING UP AND OPERATING AUTOMATIC SCREW MACHINES\*—1

APPLICATION TO THE "ACME" MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

Given a certain piece to produce on the "Acme" automatic screw machine, the first thing to consider is the best method of applying the various tools, dividing the cuts, etc., so as to get the greatest possible production without crowding any of the tools with a heavier feed than they will stand under continued service. Another point to bear in mind is to cover the work as much as possible with the top- and side-working tools, to avoid the necessity of making elaborate or expensive gages for inspecting, where if the forming tools were properly designed, a simpler gage would serve the purpose as well. Parts which should be accurate as regards diameter should be covered with a shaving tool, and every possible advantage should be taken to produce the work accurately. Experience, of course, is of great assistance in the laying out of jobs to the best advantage on the "Acme" automatic screw machine, and a clear understanding of the possibilities of this machine is one of the first requirements. To assist those desiring this information, this series of articles will be concluded with a collection of representative examples showing commendable methods of applying the tools to the work under various conditions.

To make clear and understandable the methods followed in setting up and operating the "Acme automatic," a representative piece will be taken as an example, and the various steps to be followed in setting up and operating the machine for producing this piece will be dealt with in detail. Of course there are many points that will "crop up" in the setting up of the machine for producing various parts where actual experience in work of a similar character would in many cases eliminate the necessity of experiment. However, if the operator



Fig. 1. Operator inserting Bars of Stock in Tool Spindles of the "Acme" Multiple-spindle Automatic Screw Machine

has a general idea of the various working mechanisms of the machine and their relation to each other, he will experience little difficulty in going through the various steps in setting up the average job.

#### Preparing the Machine for a New "Set-up"

Assuming that the machine has been set up on a piece of work, the first thing that the operator does is to dismantle those parts, tools, gears, cams, etc., which have to be changed

for every new job, leaving, of course, any cams or tools in position that can be used on the new piece. As a rule, the spring chucks and feed chucks are removed first and are replaced by those of the proper size and shape. Then the tools in the main tool-slide and the side- and top-working tool-slides are removed. When a straight blade cut-off tool is used in the cut-off tool-slide, it generally can be used for more than

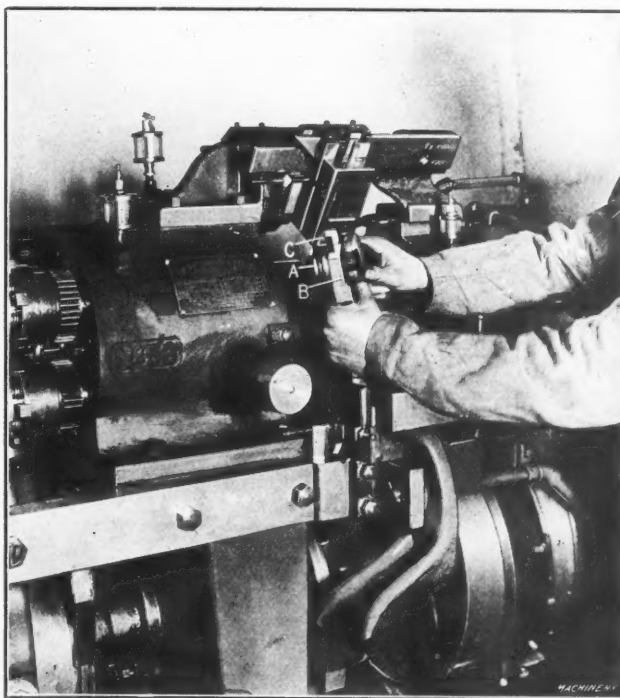


Fig. 2. Setting the Cutting Edge of the Circular Forming Tool to the Proper Height with the Tool-setting Gage

one job, so that in many cases this tool need not be removed. The cams on the main drum, and also the cams for operating the side-working tool-slides, are now removed and replaced by cams which will give the required amount of travel. The back-gears for rotating the end-working tools and the threading spindle are next removed and replaced by gears that will give the proper speeds for the work in hand.

Should the job which is to be set up be laid out by the foreman of the department, the operator, of course, is given a certain piece and instructions, and it is "up to him" to produce it in the estimated time. If, on the other hand, it is necessary for the operator to set up the job without instructions, he must first decide on the best method of applying the tools before he commences to set up the machine. As this is frequently the case, it may be advisable to give in the following a short description of some of the points which have to be taken into consideration when deciding on the best method of tooling the machine for producing any certain part.

#### Deciding on the Method of Tooling

The four spindles of the "Acme" automatic multiple-spindle screw machine sometimes tend somewhat to confuse a new operator, and to give him the impression that a clear understanding of the method of tooling is more difficult to obtain than on a single-spindle machine. The chief reason for this is that all the tools are used at once. However, this fact frequently makes it possible to rearrange the tools considerably on repeating a set-up, and what might have been considered the best method of tooling a certain piece when it was first made may prove inferior to the new method. This possibility of improving upon the method of tooling sometimes changes the order of operations to such an extent as to entirely change the method of manufacture.

For the sake of illustration, we will assume that it is necessary to produce the cap-screw shown in Fig. 3, which is to be made from cold-rolled hexagon steel, 11/16 inch in diameter across the flats. By a close inspection of this piece, it

\* For information previously published in MACHINERY on National-Acme automatic screw machine equipment, see "Cross Drilling and Milling Machine Attachments," April, 1913, and articles there referred to.

†Associate Editor of MACHINERY.

will be seen that as it is just an ordinary cap-screw, the body need not be shaved, but can be produced accurately enough for all practical purposes by dividing the cuts on the body between two box-tools, which are held in the end-working tool-slide. Referring to the diagram, Fig. 3, it will be seen that the operation at A, which takes place in the "first" position, is performed with a circular form tool and box-tool. Here it will be seen that the circular form tool has formed the head and necked the piece, whereas the box-tool, held in the "first" position tool spindle, has traveled up one-half the length of the body. Now in choosing the lead cam for the forward travel of the main tool-slide, a one-inch cam is sufficient, owing to the fact that the two box-tools are working on different bars at the same time. The second box-tool cutter, of course, is set one inch further out from the face of the main tool-slide than the first box-tool cutter in order to complete the turning on the body of the cap-screw.

#### Calculating the Production per Hour

As all of the end-working tools come up to the work at the same time, it follows that in most cases all four tools from the end would be at work on different bars at the same time.

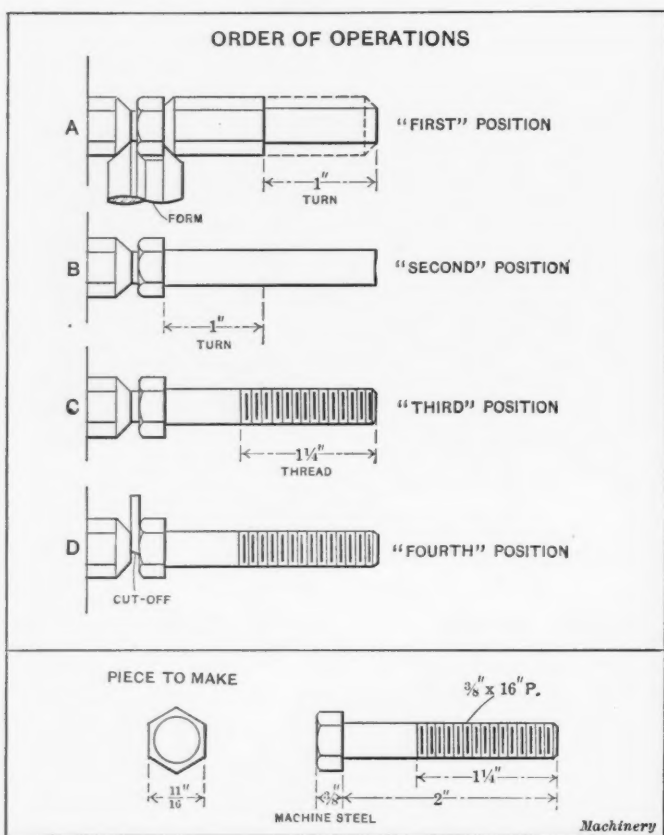


Fig. 3. Order of Operations followed in producing a Hexagon-head Cap-screw

In this case, as the screw to be made is of simple design, it only requires the use of three end-working tools—two box-tools and a die—although a pointing tool could be used if necessary to make the point on the screw after it is threaded. By considering the operations on this cap-screw, it will be found that the longest operation is that necessary to turn one-half the length of the body; then to find the production per hour, it is first necessary to determine the speed at which it is best to run the work. As a rule, ordinary cold-drawn stock can be worked at from 65 to 75 surface feet per minute for forming tools or box-tools. In this case we will select 75 surface feet as a suitable speed; then, figuring as though the bar were round and of a diameter equal to the distance across the flats, we find that a spindle speed of 420 revolutions per minute will be about right. Upon referring to the table of spindle speeds accompanying the No. 53 machine, we find that 445 is the closest obtainable. This will not increase the speed too much, so we will put the back-gears on in their positions as listed in Table VIII, which appeared in the January, 1913 issue of MACHINERY.

The next step is to find the number of revolutions of the spindle required for the box-tool to travel up one inch on the

work at a certain feed per revolution. The body diameter of this cap-screw is  $\frac{3}{8}$  inch, while the diameter across the corners is 0.794 inch, giving us a depth of cut of 0.209 or approximately  $\frac{7}{32}$  inch. Deciding on a feed of 0.004 inch per revolution, and allowing 0.040 inch for the tool to approach the work, we find that it will take 260 revolutions of the spindle for the box-tool to travel the distance required.

There are several methods followed in obtaining the production of the "Acme" automatic screw machine, one method being based on the assumed output per hour, which can be obtained by the following formula:

$$P = \frac{R \times 60}{r}$$

in which  $P$  = assumed product in pieces per hour,

$R$  = R. P. M. of work spindle,

$r$  = revolutions of spindle required to complete the longest single operation.

Then, inserting the values previously obtained in this formula, we get:

$$P = \frac{445 \times 60}{260} = 103 \text{ (approximately).}$$

Now in assuming this product no consideration has been given the time required to feed stock, index the cylinder, etc., so instead of calculating the actual time required for these idle movements, an approximation is made. Referring to Table V, which appeared in the January, 1913 number of MACHINERY, we find that the next closest production to 103 is 98.5; then by dropping down to a product of 98.5 pieces per hour, we allow sufficient time to take of the idle movements of the machine.

Another method which will be described more fully in a future article is to calculate the time required for the longest single operation in the manner just described, and then determine definitely the actual time required to feed the stock, index the cylinder, etc. This is added to the time required for the longest single operation, the sum giving the exact time required to produce one piece. This method, while considerably longer than the other, seems to have the advantage of working on some definite basis and to be more clearly understood by those not entirely familiar with the construction and operation of this machine.

#### Setting up the Machine

Taking the piece shown in Fig. 3 as an example, and assuming that the machine has been dismantled, the first thing to consider is the insertion of the proper spring chucks and feed chucks for feeding and holding the bars. A point to note here, is that a round chuck should never be used for holding either square or hexagon stock, but a chuck of the same shape as the work should always be used. After the feed chuck and spring chucks have been put in place, the bars of stock, as shown in Fig. 1, are then inserted, the chucks being opened and the bars being pushed through so that they just extend far enough out of the chucks to be trimmed off with the circular cut-off tool. As a rule, it is good practice in setting up, to put the bars of stock into the pipes for guiding them before the machine is started. In putting the reel in place, when the bars are already in the spindles of the machine, it is simply slid back over the rear bracket until it passes the end of the bars, then slid forward again, the bars passing into the pipes. What probably is better practice, is to leave the reel in place and push the rods through the pipes into the spindles, then slide the reel back slightly to facilitate chucking, and replace it again in the running brackets before starting the machine. When the stock is small in diameter the ends projecting from the rear end of the machine should be guided by the pipes of the reel, as this prevents damage to both machine and operator due to a slight twist in the bars which causes them to rotate eccentrically and buckle.

#### Selecting and Changing the Back-gears

After the stock has been inserted in the machine, and the chucks closed on it by cranking the machine, the next step is to get the desired spindle speed. This is secured by removing the back-gears as shown in Fig. 4 and replacing them with the gears which will give the proper speed for the work in hand. For this example we have selected a spindle speed

of 445 R. P. M. Referring to Table VIII, which appeared in the January, 1913 number of MACHINERY, we find that for the No. 53 machine, the gears should go on as follows: A — 52; B — 46; C — 26; D — 32. In putting on the back-gears, see that they do not mesh too closely as this will consume more power.

#### Selecting the Lead and Forming Cams

A feature about the "Acme" automatic screw machine which should be borne in mind is the fact that the lead cam located on the drum for governing the forward advance of the main tool-slide is not adjustable, but is bolted to the drum. Now for different jobs, these cam strips which are all of the same length, but have different rises, are put on the drum and clamped by cap-screws as shown in Fig. 6. For making the cap-screw shown in Fig. 3, it is necessary that the main tool-slide travel forward approximately one inch, so in this case a lead cam having a rise of one inch in its length is selected. To determine this, measure both the narrow and wide ends of the cam strip, and the difference between these two dimensions will be the lead of the cam.

To select the forming cam, measure the distance between the largest and smallest diameters of the work formed by it and divide the result by 2. In this case we find that the forming cam should have a rise of  $7/32$  inch. All forming cams are plainly marked on the end with the rise for which they were laid out. Of course it is not always possible to select a forming cam which will give the rise to within a

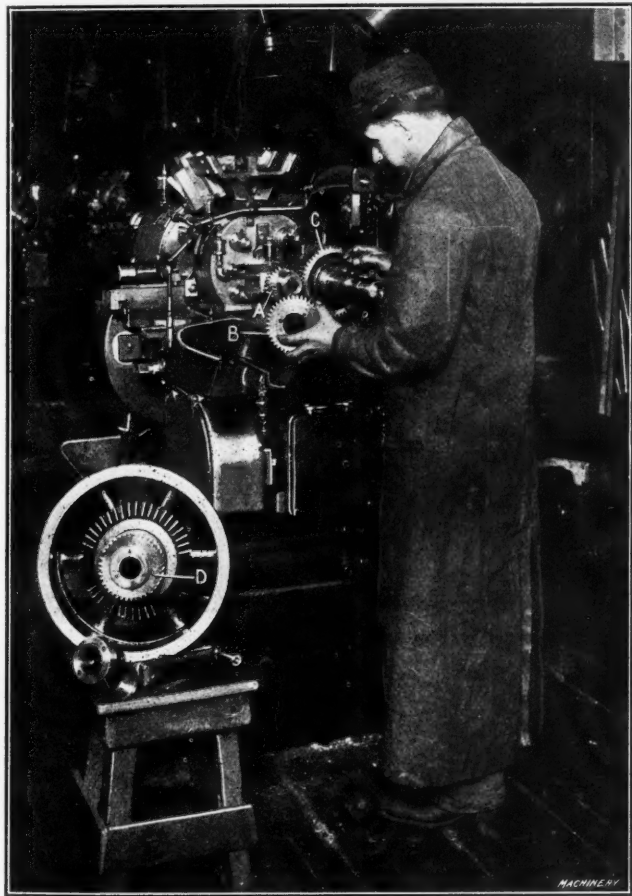


Fig. 4. Operator putting on the Back-gears to give the Proper Speed to the Work-spindles

few thousandths of an inch of that required, but this does not make much difference, as the longest single operation governs the time required to make one piece, and all the other operations are completed in that time. In this example, as is usually the case, the forming is one of the shorter operations.

To select the cut-off cam, measure the diameter of the piece to be cut off and at the same time make allowance for the angle on the point of the cut-off tool so that it will pass the center of the work. For cutting off the cap-screw shown in Fig. 3, a  $1/2$ -inch cut-off cam, which actually has a rise on the cam of  $1/4$  inch to cut through a bar  $1/2$  inch in diameter should be selected. The cut-off cams, it will be noticed, are all marked on the end to correspond with the diameter of the piece to be cut off.

#### Placing the Cams

In placing the lead cam on the drum, when the operations performed from the main tool-slide are of a heavy nature, a backing up strip should be fitted into the groove in the drum, behind the lead cam, so as to resist the thrust of the cutting tools. A starting strip should also be put on just in front of the point where the lead cam strip starts to bring the tool-slide up to the work, and a take-back cam wide enough to draw the end-working tool-slide back sufficiently to



Fig. 5. Operator selecting the Proper Change-gears for rotating the Camshaft at the Required Speed

clear the work when the cylinder is indexing, should next be put in place. This starting strip is adjusted even with the starting or narrow end of the lead cam, and is used to bring the tools up quickly to the work. When the roller is working on the "fast-angle" cams, the camshaft is rotated at an increased speed, so that all the movements when the tools are not cutting are a great deal more rapid than the cutting movements. This is done, of course, to economize time and is accomplished through the medium of the Johnson clutch arrangement described in a previous article.

In placing the cut-off cam in position, it should be put on the disk opposite the one on which the forming cam is held, and the take-back cam is also put on the same disk and attached by screws. There are two sets of holes in the disk for the cut-off cam, and the position of this cam on the disk depends on whether the "fourth" end tool position is in use or not. The disk for the forming cam has only one set of holes, so that it is impossible to adjust it.

#### Setting the Circular Forming and Cut-off Tools

The circular forming tool A, shown in Fig. 2, is held to an oblong-shaped toolholder B by a stud and nut. This holder is held in the slot in the forming slide by a strap. For locating the cutting edge of the forming tool in the proper relation to the work, a tool setting gage C is used. This is held by the operator against the bottom face of the forming tool holder as shown, and the nut bolting the forming tool to the holder is then tightened. The holder is then placed in its proper position in the slot in the tool-slide and clamped. To bring the forming tool into its correct relation to the work, the machine is cranked until the roll is just over the starting angle on the forming cam, then the screw in the back of the slide is adjusted until the forming tool just clears the work.

The adjusting screw on the slide in which the forming tool is held should be set to stop the slide just as the cam lever clears the highest point of the cam. Usually it is good practice to put a slight tension on this lever (by adjusting the

screw a little further in than necessary), so that when the extreme knife edge of the tool is removed, making the work larger in diameter, a slight outward turn of the adjusting screw will bring the work back to the required diameter.

The next step is to set the cut-off tool. This tool, when of the blade type, is set so that its top cutting edge is on a

the front turning tool to turn from 0.005 to 0.007 inch smaller than the proper diameter, after which adjust the rollers until they come into light contact with the piece to be turned. Then by adjusting the front cutting tool upward slightly, the tool and rollers will come into the proper relation with each other. In many cases a slight additional adjust-

ment of the box-tool cutter is necessary after the machine has been started to run on power feed.

Several methods are in common use for setting the box-tool to turn to the desired distance. One of these is to crank the machine until the roll just starts on the rise of the lead cam; then to operate the screw *A* in the tool spindle, in the manner illustrated in Fig. 7, until the box-tool cutter *B* just touches the work which, we will assume, has been fed out to the required length. After adjusting in this manner, tighten the screw holding the box-tool in position in the toolholder. After the "first" position box-tool has been set in position in proper relation to the work, the power feed may be thrown in to index the cylinder by operating the starting clutch lever *A*, see Fig. 8. This will bring the rod just operated upon into the "second" position. Now adjust the gage stop and set the feed stop on the lever operating the feeding mechanism so that the stock will be fed to the length of the piece to be made, being sure to ascertain beforehand that the feed tube is withdrawn sufficiently to insure the end of the rod coming in contact with the gage stop. When the

stop has been properly set, the stock fed the proper distance and the cam roll-holders set so as to give ample clearance for all tools, crank the machine until the roll on the cam roll-holder *S*<sub>2</sub> (which appeared in Fig. 9 of the December, 1912 number of MACHINERY), is in contact with the start of the rise on the lead cam.



Fig. 6. Clamping the Lead Cam to the Main Drum for governing the Forward Advance of the Main Tool-slide

line with the center of the work. It should also be set in a horizontal position relative to the forming tool, by adjusting the screw in the slide, which is provided for that purpose. After the form and cut-off tools have been set in approximately the correct relation to each other, the next step is to set the form tool so that it will turn the work to the required diameter. To do this, crank the machine as shown in Fig. 8, until the wedge is disengaged from the wedge fingers, then push the rod through the chuck until its end passes the outside edge of the circular form tool. Continue cranking until the rod is chucked and the roll on the lever operating the forming slide is on the starting point of the cam rise. The form tool can now be adjusted inward as previously mentioned, the machine started and a cut taken. It is good practice to get those parts of the work covered by the form tool to the required diameter before going further. Of course, it is necessary to set the cut-off tool to remove the formed ends during the adjustment of the forming tool.

After one piece has been cut off, it can easily be seen whether the cut-off tool has been set in the proper relation to the center of the stock. Care should be taken to see that the front edge of the cut-off tool passes a little beyond the center of the work, thus making sure that there are no burrs left on the end of the rod to interfere with the proper feeding of the stock against the gage stop. The adjusting screw in the bottom of the slot of the cut-off tool-slide provides a means of raising the tool so that its top edge comes in the proper relation to the center of the work.

#### Setting the Box-tools

Assuming that the forming and cut-off tools have been properly set, place the box-tool in the "first" position tool spindle. Then open the chuck, as previously mentioned, and feed out the stock. When the work is long or of small diameter it is good practice, in setting the box-tool, to feed the stock out only a short distance from the face of the chuck to prevent springing or bending of the bar while adjusting the tool. In setting the box-tool, release the rollers and set



Fig. 7. Setting the "First" Position Box-tool to turn up the Required Distance on the Work

After having set the "first" position box-tool, again crank the machine until the forming tool and "first" position box-tool have completed their operations and another indexing of the cylinder is about to take place. After this indexing has proceeded about half way, place the "second" position box-tool back far enough to clear the stock during the indexing operation. Continue cranking until the cam roll is in contact with the cam as before; then adjust the "second" position box-tool so that it will pick up the cut at the position where the "first" position box-tool finished, and

at the same time set the rest and front cutting tool to the diameter formed by the "first" position box-tool. To bring the box-tool out so as to turn up the correct length, an ordinary scale *C*, as shown in Fig. 7, is sometimes used. Some operators prefer the "scale method" of setting the end-working tools, instead of working from the end of the bar, as previously mentioned.

When the screw is to be pointed, a pointing tool can be held in the "first" position box-tool, or if the "fourth" position tool spindle is not used, a pointing tool can be used from this position. Assuming in this case, that we carry the pointing tool in the "first" position box-tool and that the gage stop, forming tool, box-tools, etc., have been properly set, release the set-screw holding the pointing tool which

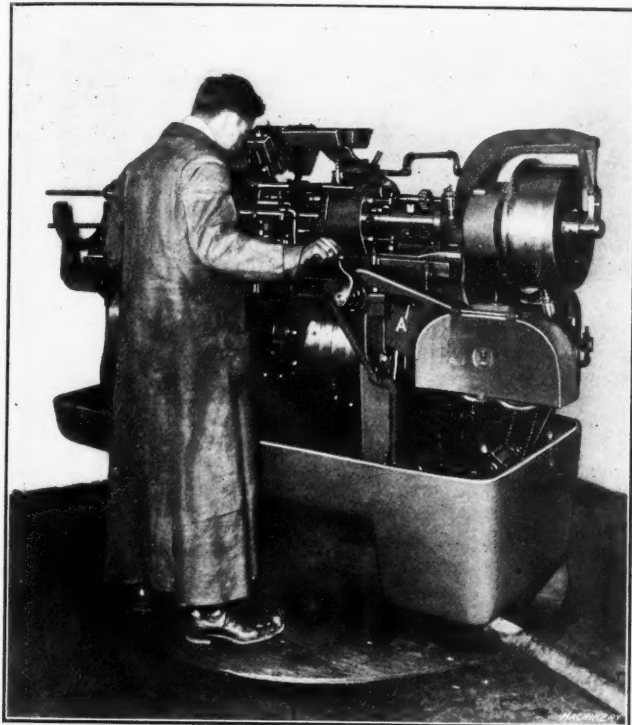


Fig. 8. Operator cranking the Machine to rotate the Cylinder and bring the Various Tools into Position when setting up

points the screw. Then crank the machine until the tool-slide travels forward the required distance, and adjust the pointing tool out until it will remove the desired amount of metal from the end of the screw.

#### Selecting Change Gears

Assuming that all the tools previously mentioned have been set in their proper positions, several pieces are made from the bars, the machine being operated by power feed. The next step is to put on the proper change gears to give the desired product. As a rule, in setting up an "Acme" automatic screw machine, the gears which have been decided upon to give the desired production are not put on until all the tools have been properly set and the various mechanisms of the machine working in the proper relation to each other. The majority of operators set up the machine on a "slow" set of gears, and after the machine has been set correctly, put on the gears which will give the desired production. Fig. 5 shows an operator making this change. The gears which he has selected for putting on the machine are shown lying on the floor. For the piece which we have chosen as an example, we decided that a production of 98.5 pieces per hour would be suitable. Referring to Table V in the January, 1913 number of *MACHINERY*, we find that the first gear *B* on the shaft should have 36 teeth, the second gear *A* (immediately in front of gear *B*, but not shown) on the shaft 82 teeth, the first gear *D* (directly behind gear *C*) on the stud 74 teeth, and the second gear *C* on the stud 28 teeth. After these gears have been put in their proper positions, the next step is to set the threading spindle.

#### Setting the Threading Spindle

On the "Acme" multiple-spindle automatic screw machine, the work-spindle is held stationary while a right-hand thread is being cut, and the die-spindle carrying the threading

tool is rotated. Then in backing off the die or tap from the work, the threading spindle is held stationary and the work-spindle rotated. The manner in which this is accomplished was explained in connection with the description of the threading mechanism in the article which appeared in the December, 1912 number of *MACHINERY*. In setting the tools for threading before starting the machine, see that the clearance between the ratchet and pawl extension is anywhere from 1/16 to 1/8 inch, when the pin block on the holder and the pin in the spindle are placed end to end (after the pin has been adjusted). It is very important that this precaution be taken as a "hang up" between these two points, resulting in the stripping of the teeth in the gears driving the holder, might occur, should this adjustment not be properly made. For this example, the front face of the die should be set almost in line with the cutting tool held in the box-tool in the "first" tool position, when the die-spindle is as far back as the tool-slide will let it go.

Now the lead cam does not advance the threading tool at the proper speed, but provision is made so that the die follows the lead of the thread. It is therefore unnecessary to take the lead cam into consideration at all as far as the feeding of the die-spindle is concerned. A point to look out for, however, is the length of the die pins which actuate the die-holder driving the threading die. These should be set so as to carry the die up far enough after the end of the travel of the lead cam has been reached, before allowing the die to rotate freely. In this case the lead cam only travels approximately one inch, while the travel of the die is 1 1/4 inch, so that it will be necessary to set out the die pins. After all the tools have been properly adjusted and are working satisfactorily, set the cam dogs which shift the clutch to direct drive to operate at the proper time in relation to the cutting tools and the indexing of the cylinder. As a general rule, the clutch should be shifted to the direct drive when the die or tap is just free from the thread and the rolls have cleared the cutting-off and forming cams. The clutch again shifts to the gear drive just before the tools begin to operate. The method of making these adjustments was described in the January, 1913 number of *MACHINERY*.

In the second installment of the article on "Automatic Screw Machine Equipment" published in the March number, the formula for determining the diameter of a thread roll was erroneously given as follows:

$$D = N \left( d_1 - \frac{d_2}{0.625} \right)$$

This should read:

$$D = N (d_1 - 0.625 d_2)$$

\* \* \*

#### THE BRITISH AERONAUTICAL EXHIBITION

The Aeronautic Show at Olympia, London, this year, was mainly devoted to the exhibition of aeroplanes of English design and manufacture, about two-thirds of the machines being British. In finish and workmanship these machines were quite comparable with the aeroplanes built in France and exhibited at the Paris Show last October. In all, there were twenty-four aeroplanes exhibited, of which six were of the hydro-aeroplane type. Fifteen were bi-planes and nine, mono-planes. One of the most interesting machines on exhibition was the Cody bi-plane which has flown over 7000 miles, reached a maximum speed of 72 miles per hour and possesses a climbing ability of 300 feet a minute. The chief novelty in construction was shown in a British built mono-hydro-plane in which all the usual guys were dispensed with and the wings were braced on their under sides with strong trusses of steel tubing. The total weight of the steel tubing for trussing the wings was only thirty-five pounds. Another hydro-aeroplane of interesting construction was the so-called "flying boat" constructed by Sopwith, which is a combination of a bi-plane and a boat built of cedar, the total weight of the boat being only 180 pounds. The boat is provided with wheels so arranged that they can be raised when it is operating in water, and dropped down when it lands on the ground.

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MAY, 1913

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### ANTIQUATED MACHINE TOOL EQUIPMENT

A large and well-known machinery manufacturing concern recently passed its quarterly dividend, which the directors explained as follows:

Business conditions since the beginning of the calendar year have been of a disappointing nature. The volume of new business has decreased and prices obtainable for machinery have declined. Demand for our classes of machinery has not been equal to the present equipment of manufacturers throughout the country. *No new competition has arisen, but existing competition is, if anything, sharper than at any time in the history of the company.* (The italics are ours.)

In some of the plants of the constituent concerns of this company, the tool equipment is notoriously poor. Machine tools thirty years old are in use, which, of course, means machines of inferior design, weak power and generally low production. Some of the plants are poorly lighted and ill-arranged, the cost of labor for handling parts and material is heavy, and the unit production per man is low.

One of the competitors of the large concern which has just passed its dividend follows quite the contrary policy as regards machine tool equipment. Instead of being content to use old machine tools thirty years behind the times, its management insists on having tools that are, if anything, ahead

of the times. The latest and best machinery obtainable is demanded and machinery built to order is provided, which promotes rapid and low-cost production, especially on parts made in large quantities. Machine tools that the big concern regard as being too *costly* and too special for its plant, are actually being thrown out by its smaller competitor as being too inefficient and too *expensive* to be kept in its service.

This example shows again that an aggregation of concerns forming a huge combination of plants has no advantage over small competitors unless it provides up-to-date machinery and methods, and employs high-grade men to manage the manufacturing as well as the selling end. The price of success is progress, and in no line of manufacture is this more evident than in the machine industry.

\* \* \*

### THE MARKING OF TOOLS

There is many a tool-room where thousands of separate tools are stored with no other marking than a card or label in front of each bin in which the tools are placed. This lack of identification makes it difficult to determine the particular operation for which each jig, arbor or special tool is intended to be used, and much time is wasted in "trying and fitting" the tools to the work to be done. In all well-organized tool-rooms, however, every individual tool is marked in some way to identify it with the operation for which it is to be used, and sometimes this marking gives almost a complete description of the purpose of the tool. No doubt this is very desirable, but it is also very expensive, because the marking of whole words on odd tools is not work that can be easily and rapidly performed. The best method is simply to give each tool a number, as a few figures can be quickly and rapidly stamped on it. Then a chart should be provided which gives the detail information required in connection with each tool. These tool numbers can be used on the drawings of the piece to be made, or on special shop operation sheets in cases where these are used. A great deal of time is saved in this way. It is much easier to keep a record of the tools that have gone out of the tool-room, and mistakes and spoiled work due to the using of wrong tools are more easily prevented. It is surprising to find that some large shops are without a proper system for marking and identifying the tools used in manufacturing.

\* \* \*

### SQUARING THE CIRCLE

A little booklet, evidently written by an amateur, on "Squaring the Circle," recently attracted our notice as an interesting example of wasted energy. Some persons with a smattering of education apparently believe that squaring the circle, that is, finding its area in terms of the square of the diameter, cannot be accomplished, simply because mathematicians have not found the number expressing the exact ratio between the diameter (or radius) and the circumference. It is true that the ratio of the diameter to the circumference of the circle is incommensurable—not capable of being exactly expressed in figures—but it has been determined with exactness to several hundred decimal places. When expressed in only four decimal places it is so nearly exact that it serves most practical requirements. The ratio to the eleventh decimal place is 3.14159265359. When calculated by the formula  $A = D^2\pi \div 4$ , assigning the common value 3.1416 to  $\pi$ , the area of a circle 100 feet in diameter is 7854 square feet. If, instead, the exact value to the eleventh place is used, the area is found to be 7853.981634 square feet, or less than 0.02 square foot difference. It is evident that any degree of accuracy ordinarily required can be obtained with the approximate value of  $\pi$ .

The history of the attempts made to square the circle is interesting reading, although now they are regarded as a lamentable waste of time and energy. One mathematician who devoted many years of his life to it ordered that the value of  $\pi$  determined by him to several hundred places be cut on his tomb. No one in this practical age need waste his time and energy on the ancient mathematical problems, of which squaring the circle is only one. They are generally regarded by able scholars as being impossible of exact determination, but even if they were solved exactly the benefits resulting would be of very little value.

## THE NEW TARIFF BILL AND THE MACHINE TOOL INDUSTRY

A comparison between the present and proposed tariff on machinery, machine tools and kindred products is given below on this page, ad valorem rates being figured approximately on the old tariff, so that comparisons can be made. The machinery schedules contain grave defects, in that they provide different rates, varying from free entry to 45 per cent., on manufactures requiring the same class of labor and consisting of the same kind of material.

While nearly every one agrees that if the bill is to become a law, the sooner it is passed the better, so that business interests affected thereby can adjust themselves to the new conditions, it is reasonable to expect that a revision of such vital importance to the industries affected should be made by men who are acquainted with their product. Certainly few Congressmen, and few people outside of the machinery industry, know what a machine tool is. If it were generally understood that all machines are made on machine tools, and that their remarkable development, due to the genius of American mechanics, has been the most important factor in lowering the prices of all kinds of manufactured articles and in perfecting machinery for reducing the cost of almost everything that we eat, wear and use, there would be a general demand to place the machine tool industry on the same basis in the proposed bill as other industries that employ the same class of labor. To cut machine tools to 15 per cent., while kindred industries have the advantage of 25 and 45 per cent., is a manifest injustice. For instance, automobiles are to be protected by 45 per cent.—a prohibitive duty—and electrical machinery by 25 per cent., although more than \$28,000,000

worth of the former and \$8,000,000 of the latter were exported in one year; while as nearly as can be computed from the imperfect Government statistics, not over \$4,000,000 worth of machine tools were exported in the same period.

The labor cost of machinery is an important item, and a comparison of wages paid in the machinery industry in Europe and in the United States, given below, will therefore be of interest.

AVERAGE WAGES IN CENTS PER HOUR

	Machinists	Tool-makers	Handy-men
Italy .....	8 to 13	12 to 17	9 to 11
Switzerland .....	12 to 17	15 to 22	9 to 11
Germany:			
Bavaria .....	13 to 15	16 to 19	9 to 10
Saxony .....	13 to 16	16 to 20	11 to 12
Berlin .....	17.5 to 20	19 to 23	12 to 13
Magdeburg .....	14.5 to 19	18 to 20	8.5 to 12
Great Britain .....	16 to 19	19 to 21*	
Belgium .....	11.5 to 18	13.5 to 22	6 to 11
* Die Sinkers.			
United States:	Machinists	Tool-makers	Handy-men.
New York City.....	25 to 33	39 to 44	16 to 28
Philadelphia, Pa. ...	25 to 37	32 to 36	16 to 25
Providence, R. I. ....	26 to 28	28 to 37	18 to 25
Hartford, Conn. ....	30 to 38	30 to 40	20 to 26
Cleveland, Ohio ....	30 to 35	35 to 40	20 to 25
Cincinnati, Ohio ....	25 to 29	28 to 33	20 to 28
Milwaukee, Wis. ....	25 to 40	30 to 40	17 to 25
Detroit, Mich. ....	30 to 40	35 to 45	22 to 30

On piecework these rates may be increased 30 to 50 per cent.

### (CONDENSED FROM SCHEDULE C—METALS AND MANUFACTURES OF)

In the following table are given comparisons of the tariff rates on iron, steel and other metal products under the proposed Underwood revision, and the schedule now in force. These data are taken chiefly from Schedule C, which covers metals and manufactures of metals. Many machines and metal products used in the industries are not specifically mentioned, and when not named are covered by the basket clause: "Articles or wares not specially provided for, etc.," in Paragraph 171, the whole of which follows:

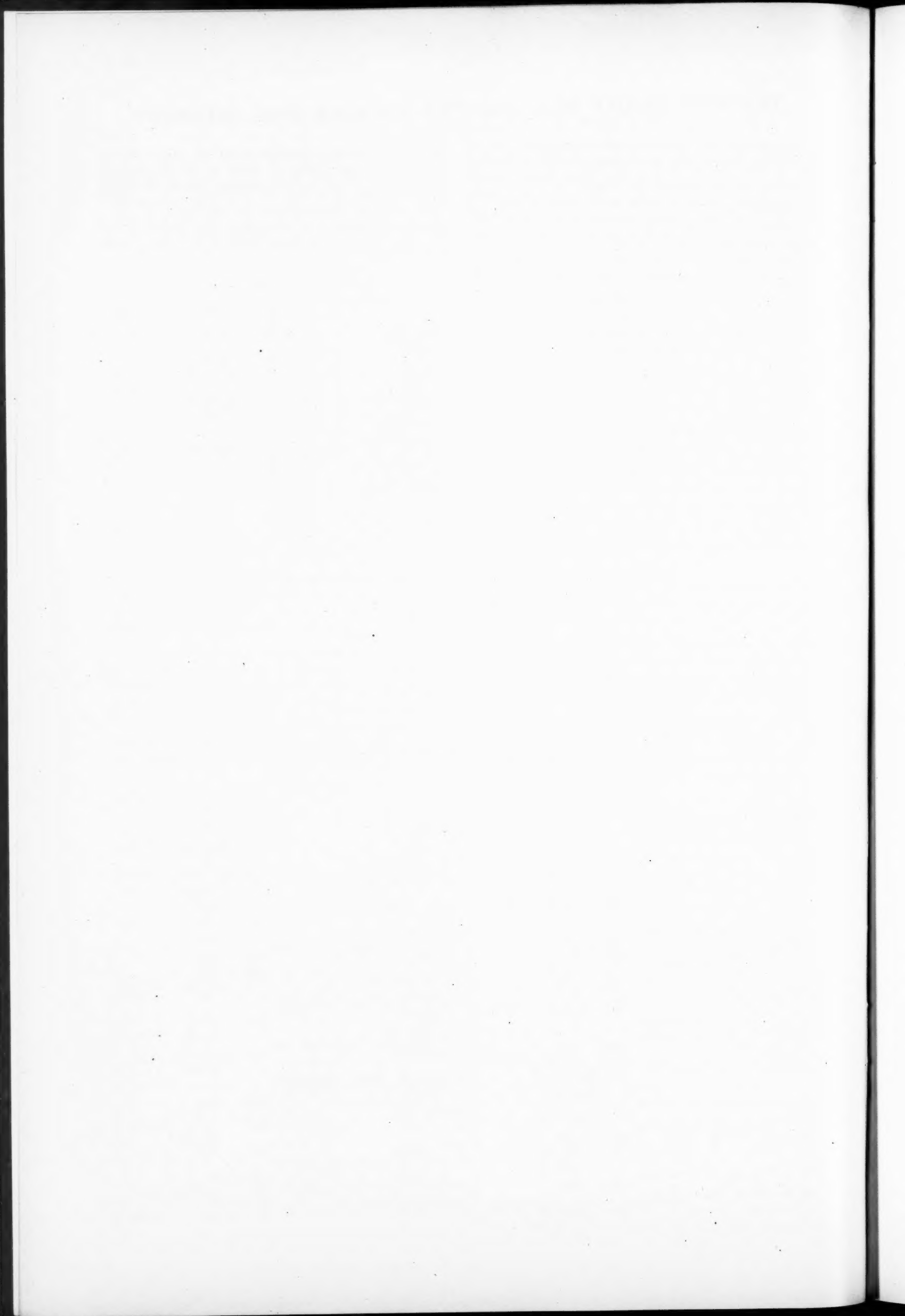
"Articles or wares not specially provided for in this section; if composed wholly or in part of platinum, gold, or silver, and articles or wares plated with gold or silver, and whether partly or wholly manufactured, fifty per centum ad

valorem; if composed wholly or in chief value of iron, steel, lead, copper, nickel, pewter, zinc, aluminum, or other metal, and whether wholly or partly manufactured, twenty-five per centum ad valorem."

Aside from lowering the tariff the Underwood bill is notable for fixing the rates generally on an ad valorem basis instead of making specific rates. The average ad valorem percentage equivalents for the specific tariffs are the U. S. Treasury figures for 1911, based on the values of the imports and respective duties collected for that year.

Machine tools are defined in the new tariff bill to mean any machines operated by other than hand power, which employ a tool for working on metal.

	Proposed Schedule	Present Schedule	Average Ad Valorem, 1911		Proposed Schedule	Present Schedule	Average Ad Valorem, 1911
Agricultural implements: plows, harrows, harvesters, reapers, drills, threshing machines, cotton gins.....	Free	Free		Forgings, iron and steel.....	15%	30%	
Aluminum, aluminum scrap and alloys .....	25%	7c. lb.	46.19%	Iron bars.....	8%	0.3c. lb.	13.80%
Aluminum in plates, sheets, bars and rods.....	25%	11c. lb.	46.19%	Iron, pig.....	8%	\$2.50 ton	15.66%
Anvils .....	15%	1½c. lb.	31.95%	Iron, round.....	8%	0.6c. lb.	34.03%
Automobiles .....	45%	45%		Iron, common plates.....	15%	0.5c. to 0.8c. lb.	32.35%
Automobile finished parts (not including tires).....	20%	45%		Iron and steel boiler plates.....	15%	0.3c. to 0.6c. lb. or 20%	37.68%
Automobile chassis.....	30%	45%		Leather belting.....	Free	15%	
Axles and forgings for axles.....	10%	¾c. lb.	14.81%	Machine tools.....	15%	30%	
Ball and roller bearings.....	35%	45%		Machinists' small tools.....	25%	45%	
Bicycles .....	25%	45%		Models of inventions to be used exclusively as models.....	Free	Free	
Blacksmiths' tools.....	10%	1¾c. lb.	17.12%	Motorcycles .....	40%	45%	
Bolts, nuts and washers.....	15%	1½c. lb.	29.07%	Nippers and pliers.....	30%	8c. lb. and 40%	59.74%
Cash registers, sewing machines, typewriters, linotypes, type-setting machines.....	Free	30%		Philosophical and scientific apparatus, solely for educational purposes .....	Free	Free	
Car wheels.....	25%	1¼c. lb.	50.63%	Pipe, cast iron.....	12%	¼c. lb.	16.30%
Chain, crane, cable, logging, etc..	20%	¾c. to 3c. lb., but not less than 45%		Pipe and tubes: lap-welded and butt-welded .....	20%	1c. to 2c. lb. or 30%	29.01%
Chain: transmission for automobiles .....	20%	45%		Professional books, implements and tools of trade in actual possession of emigrants.....	Free	Free	
Chucks, machinists' small tools, taps, dies, reamers, etc.....	25%	45%		Railway rails.....	Free	7/40c. lb.	
Copper plates.....	5%	2c. and 2½c. lb.	10.97%	Saws, band.....	12%	5c. lb. and 20%	30.26%
Embroidering machines and lace-making machines.....	25%	45%		Saws, circular.....	12%	20%	
Files, file blanks, rasps and floats of all kinds.....	25%	25c. and 77½c. doz.	61.16%	Steam engines, locomotives, printing presses.....	15%	30%	
				Steel beams and structural parts.....	12%	0.3c. to 0.6c. lb.	30.56%
				Taps, dies, reamers, etc.....	25%	45%	
				Wire rods for screws, rivets, etc..	10%	0.3c. to 0.6c. lb.	14.12%



## THE WIDENING FIELD OF THE GYROSCOPE

The gyroscopic compass has been in service for some months in six battleships and two submarines of the Atlantic Fleet. From four of these battleships, reports have been received by the United States Naval Observatory that the performance of the new compass has been highly successful and that it is now used wholly for steering, although, as a matter of precaution, its courses are still checked by the magnetic compass.

These reports and similar ones from previous tests foreshadow, for navigation, the ultimate replacement of the magnetic needle—trustworthy when its readings are corrected with much care—by the gyroscopic compass, a simple and reliable instrument of precision, which has been brought to perfection by purely engineering methods. The principles on which its action is based, are those established by the French physicist Foucault from his analysis of gyroscopic phenomena in 1851-2, viz.: First, that a rapidly rotating disk or wheel, which is so suspended as to be free to move about all axes, tends, in accordance with Newton's first law of motion, to maintain its axial direction in space; second, that, when the disk is so suspended that its axis is horizontal and motion about that axis is partly restrained, the directive action of the earth's rotation will cause the disk to "precess" or turn about the vertical axis so that its plane of rotation shall coincide with that of the earth and its axis shall point to the geographic north.

The probable relegation of the time-honored magnetic needle to the limbo—never of the forgotten—but of the archaic, marks the growing recognition by engineers of the peculiar properties of the gyroscope. Instances of its action abound in the top spinning with an inclined axis, the child's hoop rolling in an inclined plane, the steering of the bicycle, the skidding of the automobile when rounding a curve at high speed, the similar tendency of a railroad train, the lifting or depression of the stern of a torpedo boat when turning rapidly, and many others.

Owing doubtless to the complex nature of gyroscopic action, its applications in practice have been relatively few. Admiral Fleurbaey used it to give an artificial horizon for observations at sea, when the real horizon was obscured. Beginning with the mechanism of the Austrian inventor Obrey, it has since been employed almost universally in forcing the submarine torpedo to keep to the course on which it is aimed. Brennan applied it with but partial success in his mono-rail system for railroads. Schlick has used it successfully in damping the rolling of ships. Sperry, the inventor of the gyrocompass, has gone a step farther than Schlick, not only in preventing such rolling but in reversing the process and inducing rolling for freeing a ship in ice-bound waters. Finally, Russell Thayer proposed its use as a virtual keel for the dirigible balloon.

While progress has been slow, there seems little doubt that the gyroscope will yet come into its own in the field of engineering, through the full appreciation by inventors of its two unique properties: the capacity to provide a fulcrum in space and also to induce revolution, at a predetermined velocity, in an axis at right angles to its own, thus transferring its power "around the corner."

\* \* \*

The hobbing process of gear making has been severely criticized because of alleged inferiority of product. Inaccurate tooth forms were commonly produced and the gears were regarded as being fit only for second-class work and slow speeds. The high production speed possible by hobbing has concentrated the attention of machine builders and tool makers on eliminating the defects. The realization grew that the chief source of inaccuracy in modern machines is the hob. A solid hob made in the common way is a very uncertain product. No two hobs are exactly alike and no two are exactly accurate within the requirements of present-day gear-cutting practice. Limits of one-tenth-thousandth inch in accuracy of tooth forms are essential for high-speed gears. The cure for hob troubles, obviously, is grinding the teeth all over and that is now an accomplished fact. Hob makers in America as well as abroad are furnishing ground hobs true to correct shape and commercially perfect.

## NOTES AND COMMENT

The tonnage of vessels constructed in all countries in 1912 was the largest on record for any one year. The United Kingdom led with a total tonnage of 1,930,000 tons. Germany came second with 478,000 tons and the United States third, with 349,000 tons. The total tonnage constructed in all countries was 3,436,000 tons.

Alloy steel is being used with satisfaction for lathe, grinder and milling machine mandrels. When properly heat-treated, it is stronger and tougher than carbon steel and not so likely to spring or break under stress. Being free from internal stresses, it is also not so likely to spring out of shape which is a very important consideration where close limits are fixed for turning, grinding and gear cutting.

The missionary work of some large city churches includes the collection of discarded papers, magazines and books for distribution in the Far West, Canada and English-speaking colonies. The demand for some classes of second-hand literature is greater than the supply, especially technical journals. The order of demand is first, technical and mechanical publications; second women's magazines and fashion papers; and third, general fiction.

The tremendous growth of the automobile industry is well illustrated by the fact that the Ford Motor Co. is now building about 1000 cars a day. One day in January, in fact, 1326 cars were completed. The factories employ about 13,000 men working on three 8-hour shifts. An average production of 1000 cars per day would indicate that an automobile can be completed in slightly more than 100 working hours—a most remarkable achievement.

The time interval between the initial operation on steel tools and the hardening and testing is so long in some plants that thousands of parts may be in various stages of manufacture before defects in steel are discovered. The result may be heavy losses. The remedy is either to test every lot of steel carefully before starting to manufacture, or to so arrange the process of work through the plant that all departments are working close on the heels of the others.

The great majority of taps spoiled in use are broken. The breakages in nut making are very largely caused by the nuts being punched too small. An investigation made by the Wells Bros. Co. of the conditions in nut tapping concerns showed that fifty per cent of the nut sizes tapped by half the makers were punched too small. The folly of such practice is evident. Taps must not only tap but ream small holes to thread root diameters. The extra torsional stress causes much unnecessary breakage.

The Hamburg-American steamship *Imperator*, which for the time being is largest in the world, having a length of 919 feet, breadth 98 feet, depth 62 feet and 50,000 tonnage, will sail from Hamburg for New York, May 28. The vessel is of a new type as regards cellular construction, water-tight bulkheads and other safety provisions. It carries three captains, one with the rank of commodore, and one captain will always be on the bridge. Two wireless operators, day and night, will be on duty. The lesson of the *Titanic* apparently was not lost.

Gas engine poppet valves are difficult to keep in tight condition because of pitting, warping and carbon deposits, incident to the high temperature in which they work. Frequent grindings are necessary to prevent leakage and waste of gas. The peculiar characteristic of tungsten steel known as "red hardness," that is, the retention of initial hardness up to a temperature of 1700 degrees F., has been taken advantage of by one manufacturer to make an engine poppet valve that is unaffected by the heat. Tungsten steel valves are hardened and are claimed to retain a mirror-like finish on the seats indefinitely, regrinding rarely being required.

A still exhibit at a convention, exposition or other place where people congregate is of little force as compared with one that is alive and moving. Even things that in themselves are always passive, like hand tools, acquire much greater attractiveness in a show window when mounted in a revolving case. Tool manufacturers have found that machinists' tools mounted in revolving cabinets attract much greater attention than the same tools mounted in the same manner, but standing still.

It is difficult to get a satisfactory wood floor on the ground—almost impossible. After five years' use, the Aberthaw Construction Co., of Boston, has taken up a floor laid with plank driven into tar, with hardwood above this, and the plank came out as powder. It is obvious that fermentation will set up wherever air is kept from timber that has any sap in it. The wood top is very nearly airtight. The tar is absolutely so. The result is that disintegration of the plank will occur, as might be expected. For ground floors use either cement, asphalt, or tar concrete if possible.

One of the cheapest advertisements that a concern can use especially if in sight of a railroad is a large tasteful sign. This seems so obvious that it is a matter of considerable surprise to find well-known concerns that have no large signs and even no small signs over their doorways to identify the plant. This practice seems unbusinesslike and one to be deprecated. If the reason is modesty we think that it is a case where modesty is carried to the breaking point. Surely concerns doing business with the public owe to the public the duty of making easy the finding of their plants. The time lost when means of identification are not provided may often be a serious matter.

One of the means proposed for making kerosene available in motors designed for gasoline fuel is preheating the air supply as it is admitted to the carbureter, by an electrical device. If the air supply can be drawn through the carbureter at a comparatively high temperature the kerosene will be gasified without difficulty. The device for heating the air is an electric coil energized by a storage battery or the dynamo now provided for lighting, engine starting, etc., on high-grade cars. An advantage of this system is that, if properly designed, the engine can be made to start on kerosene. A few moments' application of current to the coil in the air supply pipe serves to heat it to the required temperature.

Designing and building special machinery is interesting work especially to men of considerable inventive ability, but it is likely to prove unprofitable if conducted at the usual rates of compensation. Under these conditions there is little of profit or honor. The alleged inventors claim all the credit if the machines are successful, but are often quick to blame the designer if his work does not prove as successful as they have fondly hoped. The designer and builder of special machinery who has to assume responsibility for its success should, as a rule, demand better pay than he receives. The fact that the work is unprofitable as now done is shown by the fact that special machinery building concerns are going into manufacture wherever they can find a profitable line to engage in.

In northern latitudes where the snowfall is heavy, much trouble is caused by snow melting on the roofs of shops and the water damming up at the eaves. When built in the usual manner, the roof cornices projecting beyond the walls of the shop are unheated and consequently the snow on them does not melt in cold weather. The melting snow on the main part of the roof runs down to the cold cornices, freezes and forms a dam behind which the water is held. Leaks result, which are difficult to stop. The roof of the plant of the Fellows Gear Shaper Co., Springfield, Vt., is built with hollow cornices so constructed that the heated air of the shop circulates through them and keeps the eaves warm. This, effectually prevents damming up and incident troubles from leakage.

The Blanchard Machine Co., Cambridge, Boston, Mass., uses a simple and effective means of fixing face grinding wheels in the iron retaining ring. Instead of employing a contracting clutch to grasp the wheel, a cast-iron ring is turned, bored  $\frac{1}{4}$  inch larger in diameter than the wheel and internally grooved. The wheel is set in the ring centrally, thus leaving an annular space  $\frac{1}{8}$  inch wide around it. Into this space is tamped a fluid mixture of Portland cement and sand. The cement hardens in forty-eight hours and holds the wheel firmly. The advantages of this method are simplicity, low cost and absence of compressive strains. The wheel is held by a bond which unites it to the iron ring firmly and permanently.

Experiments have been undertaken in Germany with a view to determining whether wire ropes made of alloy steels of very high tensile strength can be safely bent over pulleys to the same extent as winding ropes made from ordinary wire used for this purpose. A fear had been expressed that ropes made of very strong material would not be able to stand up as well when frequently bent over sheaves or drums. The tests indicate, however, that the number of safe bendings of a rope increases with the increase of tensile strength of the wire, and that it is not necessary to use larger pulleys for ropes made of stronger material. Of course the number of safe bendings increases rapidly with an increase in the radius of the pulley or drum.

A simple method of segregating work for machines is employed in the shop of the Wells Bros. Co., Greenfield, Mass. Where a large variety of work of the same general class is waiting for a machine operation, it is helpful to let the operators as well as the foreman see just what is on hand. This is accomplished simply by laying off with paint lines a series of rectangles on the shop floor within which the trays of taps to be machined are set. These rectangles are marked to indicate the size and pitch of the taps to be placed therein. The foreman can tell at a glance just how the work is running, what machines are fully supplied with work, and what machines are running out of work. The practice, of course, is to keep a machine on one class of work so far as possible, and thus avoid unnecessary changes of set up.

Since high-speed steel has come into general use the discovery has been made that carbon steel tools can be run much faster than commonly supposed. A user of high-speed drills ran out of stock of drills and being in a great hurry to finish a job gave the men carbon steel drills with instructions to use them with the same feeds and speeds. To the surprise of every one concerned the drills stood up to the work as well as or even better than the high-speed steel drills. There are several reasons for the improvement in capacity. Drilling machines and other machine tools have been greatly strengthened in every part since the advent of high-speed steel, and consequently are much stiffer and more powerful. Another factor that makes for higher speed is flood lubrication on the cutting points, and still another is that the maximum capacity of carbon steel tools was rarely reached in the past even with the weak machine tools then in use.

One important advantage of individual motor drive for machine tools is the elimination of overhead countershafts and belts that obscure the light. Separate motors for small machines, however, are of questionable economy. The initial cost of installing motors and controllers on each small machine is a high percentage of the total machine installation cost. The overhead transmission defect can be overcome by arranging machines in rows and driving them from jackshafts on or near the floor at the back or directly beneath the bed of the machine in the case of lathes. Manual training schools use the F. E. Wells & Son Co.'s speed lathes largely. These machines are built with the countershaft mounted on the legs of the machine. An Oldham coupling is provided at each end of the shaft to engage the shaft of the next lathe and thus convey power to it. The arrangement is neat and effective. The cone pulley and belt beneath the bed are guarded so that the boys cannot come in contact with it.

### A DIFFICULT GEAR-CUTTING PROPOSITION

When quantities of gears must be cut from blanks having relatively small bores by which they must be held for the gear cutting, it is usually difficult to decide upon the best way

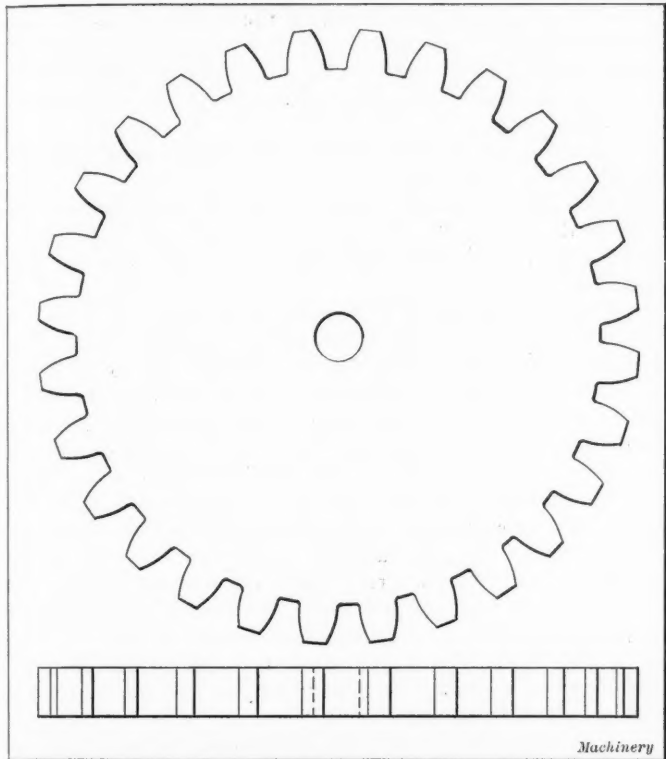


Fig. 1. The Gear to be cut—Actual Size

to handle the work; for if the gear is to run smoothly when in use, the teeth must be cut truly concentric with the bore. It is obvious that an ordinary arbor of small diameter constitutes

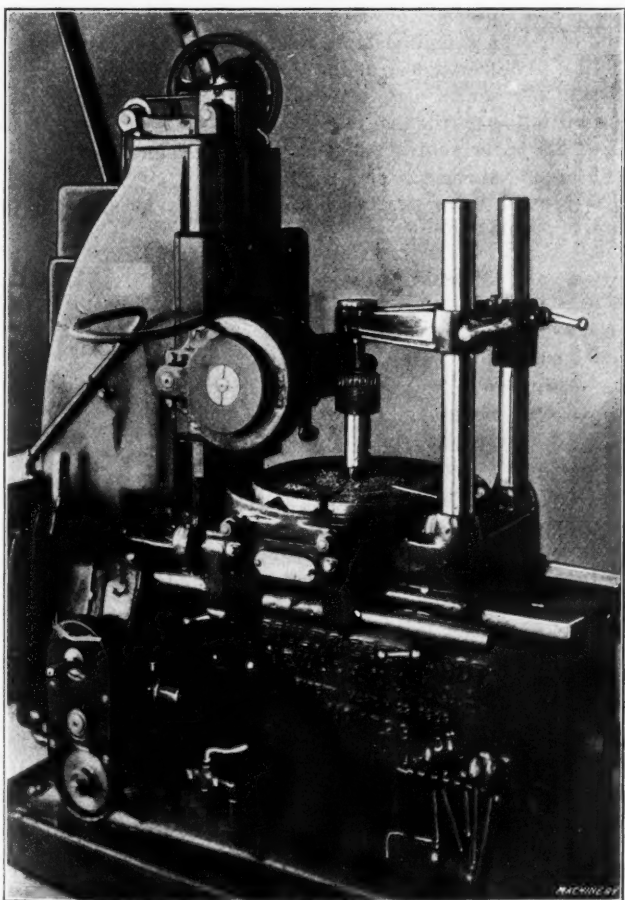


Fig. 2. Hobbing the Gears on a Gould & Eberhardt Gear Hobber

a delicate support when cutting coarse pitch gear teeth that are at a considerable distance from the point of support.

The Jones Speedometer Co., at its Bush Terminal factory,

Brooklyn, N. Y., is making quantities of steel gears which must be cut with 28 teeth of 9 pitch. A representation of a completed gear of this character is shown in Fig. 1. It will be noticed that the central hole is but  $\frac{1}{4}$  inch diameter and as the blank is  $\frac{1}{4}$  inch thick and 3 inches diameter it is a difficult proposition to support these gears for cutting on a commercial basis. The work is performed on a Gould & Eberhardt gear hobbing machine as shown in Fig. 2, using an equipment devised by the machine makers. The gears are supported upon an arbor ten at a time and cut in the usual way. From the halftone illustration it is impossible to see just how the gears are held, but by referring to the line illustration Fig. 3, it will be seen that the hobbing machine arbor *A* is fitted with an auxiliary arbor *B*, which is  $\frac{1}{4}$  inch in diameter. This auxiliary arbor is made of chrome-nickel steel, hardened and ground and is fitted into the hobbing machine arbor with a standard taper and held in place by a key *C*. Ten gear blanks *D* are placed upon this arbor and then a hardened and ground bushing *E* is slipped

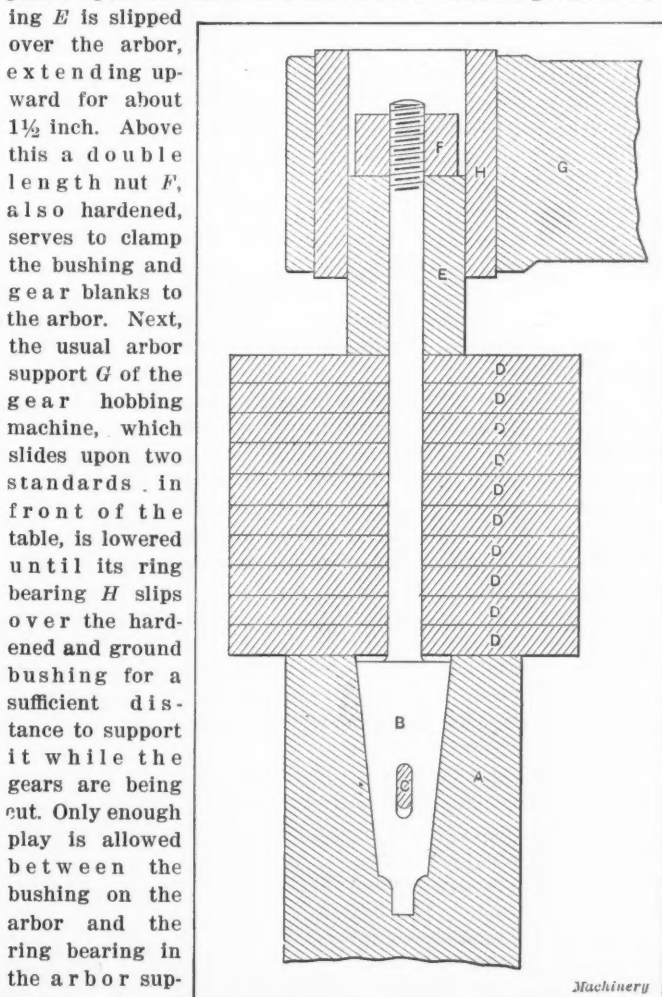


Fig. 3. Details of Method of supporting Blanks on Special Arbor

over the arbor, extending upward for about  $1\frac{1}{2}$  inch. Above this a double length nut *F*, also hardened, serves to clamp the bushing and gear blanks to the arbor. Next, the usual arbor support *G* of the gear hobbing machine, which slides upon two standards in front of the table, is lowered until its ring bearing *H* slips over the hardened and ground bushing for a sufficient distance to support it while the gears are being cut. Only enough play is allowed between the bushing on the arbor and the ring bearing in the arbor support to allow it to turn during the hobbing operation.

Of course there is a good deal of strain on the small arbor, but by using the best steel and hardening methods, the arbors last for a considerable length of time. The ends of the teeth as well as the sides and bottoms are finished by the hob. The cutter revolves at the rate of 120 R. P. M., and the hob feeds downward at the rate of  $\frac{1}{32}$  inch per revolution of the table. The speed at which the gears are cut is remarkable, ten gears being finished in twenty-five minutes.

C. L. L.

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The Wells Bros. Co., Greenfield, Mass., has established a circulating library for its employees to give them the use of technical books, magazines and catalogues. The idea of circulating catalogues is particularly good. Most concerns receive large numbers of catalogues which are scrupulously indexed and filed away where few ever see them. With the circulating method they are seen by the men who often get valuable ideas from them. The plan is one that could be advantageously followed generally.

## MODERN PRACTICE IN MANUFACTURING PLANT APPRAISAL

ON THE DETERMINATION OF VALUES OF THE ELEMENTS OF A GOING CONCERN

BY CHARLES W. MCKAY\*

The constantly increasing demand for the scientific valuation of manufacturing plants has created a new field for the mechanical engineer. While appraisals have been made for many years by appraisers who base their estimates entirely upon individual judgment, it is only within a comparatively short time that work of this nature has been placed on a scientific basis, and a study made of the underlying theories of depreciation. The outcome has tended to standardize results and to reduce to a minimum the discrepancies due to individual judgment.

Several books have been written on the appraisal of public utility properties, but in taking up the study of the appraisal of manufacturing plants some time ago it was found that a comparatively small amount of information was available in published form.

The appraisal of the equipment of a plant engaged in the manufacture of electric motors and generators offers several interesting problems, and it is the purpose of this article to outline some of those encountered in the recent appraisal of a plant of this nature.

The method pursued in appraisal work is somewhat dependent upon the purpose of the appraisal even when the appraisal is based on scientific methods. No matter how proficient an engineer may be, there are times when it is impossible for him to determine absolutely the value of a machine. He may know that his value is correct within a reasonable range, but he cannot deny that a value varying a few dollars one way or the other would be equally justifiable under certain conditions. If he is making an appraisal for the prospective buyer of a plant he will naturally take the lower range of values in cases of this kind, knowing full well that the expert retained by the owners will take the upper range, and *vice versa*. If the appraisal is made for the owners for purposes of taxation, accounting and insurance it is well to take average values.

The plant under consideration was equipped for the manufacture of electric fans, motors ranging from one-seventh to fifty horsepower, and generators of corresponding kilowattage. The appraisal was for the purpose of determining present and replacement values of the plant for insurance and accounting purposes.

There seems to be a discrepancy in the definition and application of terms used in appraisal work and a brief explanation of terms and underlying theories may serve to make the following discussion clearer:

**Unit Plant.**—A unit portion of the equipment of the entire plant.

**Replacement Value.**—Actual cost of replacing a unit of plant with plant of the same type at prevalent market prices at time of appraisal. Replacement value is, then, the market price of the machine in question plus freight plus cost of installation. In the case of large machine tools, the freight and installation items are large enough to be well worth considering, especially when expensive foundations are necessary. In the appraisal under consideration an allowance of five per cent of the market price of the machine was made to cover freight and ten per cent to cover installation. In evaluating small parts of machinery and small tools these items are practically negligible when considering individual tools. Of course in appraising the contents of a tool-room where large quantities of tools have been purchased in bulk some allowance should be made for freight.

**First Cost Installed.**—The original cost of unit plant at market prices prevalent at the time of purchase of the plant under consideration plus freight and installation. The first cost installed can often be obtained directly from the books of the company.

**Scrap Value.**—The actual cash return brought by the sale of materials (iron, copper, etc.) used in the construction of a machine or tool at current market prices less cost of junking. The cost of junking will be high in the case of large

and unwieldy machines, and in some cases will offset the return from sale of scrap, making the net scrap value zero or even a negative quantity.

**Depreciation.**—The lessening in value of unit plant due to (a) wear and tear (b) age and deterioration, (c) inadequacy and obsolescence.

**Depreciable or Wearing Value.**—The replacement value of plant less the scrap value.

**Depreciated or Present Value.**—Value of unit plant at the time of the appraisal. Present value equals the replacement value less the accrued depreciation at the time of the appraisal.

The determination of the replacement value is simply a matter of applying unit prices to the machine or tool in question with proper additions for freight and installation. A careful check of unit prices is of course necessary to ascertain their accuracy at the time of the appraisal. The increased costs of material and labor have caused a marked rise in the prices of certain of the larger machine tools within the past decade. This fact was very evident in the appraisal in question in comparing present market prices with original costs as shown on the company's books. In the case of the smaller machine tools, prices in many instances have decreased within the past few years. Inasmuch as these tools are largely produced by labor-saving machinery this fact can be attributed to the introduction and perfection of automatic and semi-automatic machinery, and to increased efficiency in shop methods.

The computation of the theoretical present value can be most easily effected by applying an annual rate of depreciation directly to the wearing value and subtracting the result from the replacement value. The wearing value equals the replacement value less the scrap value. The scrap value has a definite ratio to the replacement value for each type of plant. The information as to life of machine tools, small tools, etc., was compiled from averages obtained from actual practice. The reciprocal of the life of a machine or tool gives the rate per cent which when applied to the wearing value and multiplied by the age in years gives the accrued depreciation. This latter subtracted from the replacement value gives the present value.

The present value can be obtained directly by applying the following formula:

$$\text{Present value} = \frac{a(l - f + fr)}{l}$$

where

- $a$  = replacement value,
- $b$  = scrap value,
- $f$  = age of machine,
- $l$  = life of machine,
- $r$  = ratio of  $b$  to  $a$

The following list of average lives of various types of plants includes all three of the items given in the definition of depreciation, *i. e.* (a) Wear and tear; (b) age and deterioration from natural causes; (c) inadequacy and obsolescence. If item (c) were not considered, the averages would be considerably higher.

**Large Machine Tools.**—(Boring mills, planers, engine lathes, etc.) Estimated life twenty-five years.

**Small Machine Tools.**—(Lathes, small drill presses, shapers, bench tools, etc.) Estimated life twenty years.

**Small Parts.**—(Jigs, chucks, fixtures, etc.) Estimated life fifteen years.

**Small Tools.**—(Reamers, boring bars, drills, etc.) Estimated life ten years.

**Miscellaneous.**—(Closets, tool-stands, shop furniture, etc.) Estimated life fifteen years.

**Motors and Electrical Equipment.**—Estimated life twenty years.

**Shafting.**—Estimated life fifteen years.

**Belting.**—Estimated life ten years.

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After the present value has been obtained by either of the methods outlined above, allowance should be made for the actual condition of the machine or tool in question as ascertained by the careful personal inspection of the appraiser. For example, two drill presses of the same make and size, recently installed, are operating side by side. One is found to be in excellent condition while the other has a table badly mutilated by careless operators. Obviously the accrued depreciation on the second should be greater and the present value less than on the first. It is in cases of this kind that the appraiser's judgment comes into play.

The actual appraisal of a large plant may prove an expensive operation unless the work is carefully planned beforehand. The method adopted in the appraisal under discussion is outlined here. The plant was divided into twenty-five or more departments, each with a foreman, for performing different stages in the process of manufacture and assembly of the various types of motors and generators. A set of floor plans was available giving approximate locations of machine tools, benches, etc., and with the aid of these it was a comparatively simple matter to locate and identify the machinery.

Each department was appraised as a unit. It was found advantageous to explain briefly to the foreman in charge the object of the appraisal and obtain from him any information he had at hand as to obsolete tools and contemplated changes in machinery. The foreman then instructed the operators to arrange all tools so that they would be readily accessible for inspection by the appraiser, except those drawn from the tool-room. The appraiser then carefully inspected each machine with its equipment, making note of condition, tool numbers, etc. In this way the inspection was accomplished without confusion and with a minimum of interference.

The next step was the identification and inspection of the miscellaneous equipment, *i. e.*, benches, tool cabinets, shop furniture, etc. The appraisal of the belting and shafting and the contents of the tool-room was made separately on Sundays and holidays when the plant was not running.

The tabulation of the mass of data obtained in an appraisal of this nature in a manner suitable for insurance purposes, and without confusion, is a problem requiring thought and care. In the present case, each class of plant equipment, *i. e.*, machine tools, motors, small tools, etc., was tabulated separately for each department with totals for groups and for departments. The following illustration of the tabulation under the caption small tools will give a clearer idea of the plan adopted:

Tool No.	Used on Machine No.	Description	R. Val.	P. Val.
.....	.....	.....	.....	.....

A summary of the totals tabulated in the following form made it possible to see at a glance the results of the entire appraisal:

SUMMARY OF SHOP EQUIPMENT

Department	Machine Tools		Elec. Equip.		Etc.	Total	
	R. Val.	P. Val.	R. Val.	P. Val.	R. and P. V.	R. Val.	P. Val.
Dpt. 1 bldg. 4.	.....	.....	.....	.....	.....	.....	.....
Dpt. 2 bldg. 4.	.....	.....	.....	.....	.....	.....	.....
Etc., etc.	.....	.....	.....	.....	.....	.....	.....
Totals	.....	.....	.....	.....	.....	.....	.....

The proper method of appraising patterns and drawings is a subject regarding which there is considerable difference of opinion among appraisers. A detailed inspection of patterns is not feasible unless the manufacturer is willing to have the superintendent or some official equally well informed go over the stock with the appraiser and furnish information as to obsolete and obsolescent patterns. It often happens that a company's sales contracts require them to furnish duplicate parts on demand. This necessitates the preservation of patterns for machines superseded by those of more recent design in order to fill occasional orders. Obviously, the only way the

appraiser can know of these cases is by the personal assistance of a representative of the company.

In the plant under discussion a satisfactory compromise was effected by going over the pattern books with the superintendent and obtaining the original cost and date of manufacture together with information as to obsolete and obsolescent patterns. It was found that approximately ninety per cent of the patterns made during the first eight years of the plant's operation were obsolete, fifty per cent of those for the next four years were obsolete, and ten per cent for the five years preceding the appraisal.

The appraisal of the drawings was based on the assumption that each drawing is a necessary accessory of the pattern built from it. The value of the drawings therefore bore a definite ratio to the value of the corresponding patterns with the exception of drawings relating to obsolete patterns. While from time to time it may be necessary to destroy obsolete patterns in order to avoid congestion in the pattern store room, it is rarely advisable to destroy the corresponding drawing. The drawing requires little space and can easily be preserved to provide for the construction of a new pattern if occasion demands. The valuation of the office equipment completed the appraisal here described. In conclusion it may be said that the appraisal of a modern manufacturing plant requires as careful analysis and presents as many original problems as any other line of consulting engineering.

\* \* \*

VARIATIONS IN TOOL STEEL

Variations in tool steel are puzzling to users, and they are prone to charge the steel makers with carelessness when bad results are obtained with the same methods of hardening and tempering that have been used with success ordinarily. Steel makers are keenly alive to the need of uniformity and constantly strive to improve their product, but are likely to overlook the limitations of equipment possessed by the average user. Take, for example, a steel that has excellent characteristics when hardened within a comparatively wide range of temperatures—say between 1400 and 1500 degrees F. The maker uses a formula for his mixture that has been determined by many experiments. The average user finds it satisfactory as he can hold hardening heats to the limits which insure success. But now suppose the ambitious steel maker finds that a modification of his formula, in some particulars, materially improves the steel but narrows the limits between which it should be hardened. He is likely to put the new formula into use, forgetting that the average user cannot or will not treat the steel as he does. The result will be that some users find the steel very satisfactory indeed while many others suddenly discover that their standard steel has "gone back on them," and a howl is raised that the steel is no longer good.

\* \* \*

In an article in the *Railway Age Gazette*, Mr. Henry W. Jacobs relates some of his impressions of European railway practice. It is interesting to note that so far as regards railway development and machinery, the time-honored European conservatism does not seem to have retarded progress. To quote from Mr. Jacobs' article:

"I had often heard of the ultra-conservatism of Europeans in adopting changes, but I must confess that my personal observations inclined me rather to the opposite view. I found European engineers and shop officials only too ready to accept changes in existing practice that could be shown to be an improvement. For instance, their new shop layouts are well designed and the most modern machinery is installed, some of it, as stated, coming from America. Roundhouses are modern in construction, such details as power driven turntables (even with the smaller locomotives used abroad), efficient ventilation, etc., being given attention. In modern improvements in locomotive design, we must give Europe credit for making the fullest practical use of superheaters, compound and multi-compound engines, tank engines for all classes of service except the heaviest long-distance through express and freight trains; and we should not ignore the practical conservation resulting from the general use of briquetted fuel."

### A "THREE POINT" MICROMETER AND ITS USE

In the production of perfect and smooth running automobile motors, it is necessary for the crankshaft and connecting-rod bearings to be correctly fitted to the crankshaft and crankpins, and the latter must also be properly hardened and ground. A running balance of all the moving parts or internal members of the motor is also essential. Many motor manufacturers are content to measure the diameters only of their crankpins, and to hold these dimensions to within 0.0002 inch. The Continental Motor Mfg. Co., with plants in Muskegon and Detroit, Mich., has found that a crankpin which appears to be accurate, when measured with an ordinary mi-

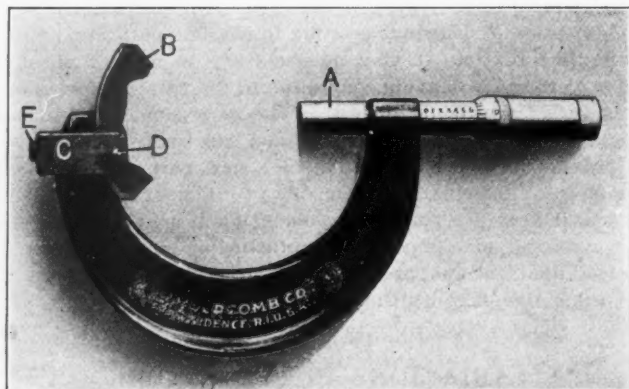


Fig. 1. Three-point Micrometer used for detecting Low Spots on Crankpins

crometer, does not necessarily give a perfect fit in a correctly reamed bearing. The reason for this is that it has been ground "three cornered."

The three-cornered shape of the crankpin is not noticeable with an ordinary micrometer, which only enables the diameters of the pin to be determined at different points; this will be seen by referring to A in Fig. 2, where the points of the micrometer are shown bearing on a high and a low spot at the same time, thus giving practically the same reading all around the pin, when it is really out of round. If this crankpin, which has been ground three-cornered, is placed in a perfectly round bearing, it will be found that it bears heavily in spots, and yet the ordinary micrometer fails to show any error in diameter. The reason for this, as was previously mentioned, is that when the spindle of the micrometer is on the low spot, the anvil is on the corresponding high point, and *vice versa*. Generally

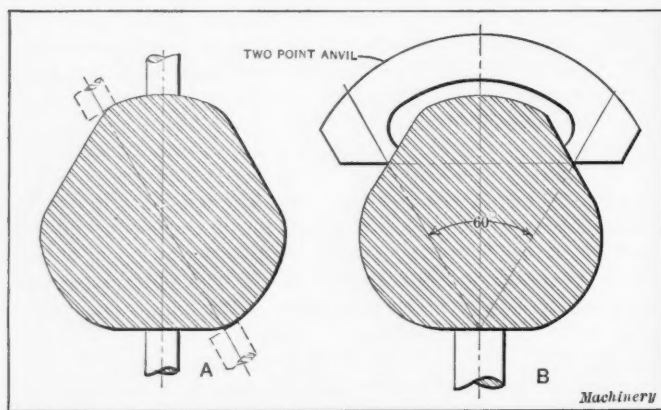


Fig. 2. "Three-cornered" Shape of Crankpin greatly exaggerated

when the crankpin bears heavily in spots, the bearing is scraped in an attempt to correct the bearing surface; this is not effective, however, if the pin is out of round.

Considerable trouble was experienced by the Continental Motor Mfg. Co. in obtaining a correct bearing between the crankpins and connecting-rod bearings, and several methods were tried in an endeavor to overcome the difficulty. The various methods that were tried proved unsuccessful until a means was found for measuring the crankpins accurately. To do this a "three-point" micrometer was made, which is simply an ordinary micrometer provided with two anvils instead of one. As shown at B in Fig. 2, the two anvil bearings form the two upper corners of an isosceles triangle, the spindle

of the micrometer forming the lower corner, when the micrometer is set to the correct diameter. Now by referring to B in Fig. 2, it will be seen that no matter at what position the micrometer is placed on the work, it is impossible to get an inaccurate measurement over a high and a low spot; consequently the low spots of a three-cornered crankpin can always be located. With this three-point micrometer low spots, with an error as great as 0.002 inch on a crankpin  $1\frac{1}{8}$  inch in diameter, were located, which an ordinary micrometer could not detect.

There are several reasons given in an endeavor to explain why a crankpin is ground three-cornered. One is that soft spots tend to reduce its diameter more at some points than at others during the grinding operation. This reason does not, however, prove that it should be ground three-cornered. Another reason, more plausible, is that as the bearings of the grinder wear loose, the crankpin springs away and makes a high spot, when the heaviest part of the crankshaft turns away from the grinding wheel; the opposite effect takes place when the center of gravity of the crankshaft changes its position in relation to the wheel. The design of the crankshaft may have something to do with the shape to which the crankpins are ground, but does not prevent the grinding of low and high spots. By properly balancing the work and keeping the



Fig. 3. Inspector using the "Three-point" Micrometer for detecting Low Spots on Crankpins

bushings in the grinder in good condition, the three-cornered effect can be obviated. The Continental Motor Mfg. Co. constantly uses the three-point micrometer to ascertain, as soon as possible, when any error is creeping in.

To convert an ordinary micrometer into one having three contact points, a sleeve A is made to fit the spindle, as shown in Fig. 1. The reason for using this sleeve is that the regular spindle of the micrometer would soon become worn in one point on the front edge, owing to the constant friction on the crankpin. This sleeve is made so that it can be removed when worn on the edge, and a new one put in its place. The two-point anvil B is made from a flat piece of tool steel about 5/16 inch thick, and is provided with a hole for the anvil. This block B is hardened and lapped on the contact surfaces, and is held to a machined seat on the micrometer frame by a yoke C, pin D and the headless screw E.

This micrometer is not used for taking direct measurements, but is intended for determining whether the crankpin has been ground out of round. As shown in Fig. 3, the crankshaft to be measured is supported in vee-blocks located on machined blocks on the work-bench. After the inspector has measured the crankpins with an ordinary micrometer to see that they are of the correct diameter, he applies the three-point micrometer in the manner illustrated. Crankshafts are not allowed to pass the inspector if the pins are out of round more than 0.0002 inch.

D. T. H.

## THE HISTORY OF THE SEWING MACHINE

The following historical notes on the history of the development of the sewing machine have been compiled by Mr. J. J. Darby, principal examiner, United States patent office: The earliest attempt at sewing by machinery of which there is any authentic record was in 1755, in which year a machine was patented in England by Charles F. Weisenthal. In this machine the stitch was formed by a needle, having two points with an eye at mid-length, which passed completely through the goods in imitation of hand sewing. This was followed by an English patent dated July 17, 1790, granted to Thomas Saint, for a machine that embodied several features which are employed in the modern sewing machine, namely, an overhanging arm, a horizontal cloth plate, a vertically reciprocating needle, and a feeding device. The needle, notched at its lower end, pushed a loop of thread through a hole previously made by an awl. The loop thus formed was held beneath the goods and the next loop was passed through it, thus making what is known as the chain stitch. In 1804 an Englishman named Duncan made a chain-stitch machine that employed two hooked needles, and in 1830 a Frenchman named Barthelemy Thimonier invented a machine which embodied the Saint principles with the exception that the loop of thread was pulled instead of pushed through the fabric.

### First American Patent

The first American patent for a sewing machine was issued to a man named Lye in 1836. A fire which occurred that same year destroyed all the patent office records, so the construction of this machine is not known. In the years 1832 to 1834 Walter Hunt, of New York City, built what was probably the first lock-stitch machine. This was provided with a curved needle (with an eye near the point) mounted on a vibrating arm. A loop was formed beneath the cloth by this thread-carrying needle, and a shuttle carrying an additional thread was passed through the loop thus formed, making a lock stitch. Hunt, however, did not apply for a patent until after the granting of the Howe patent in 1846, and his application was refused.

On February 21, 1842, patent No. 2466 was granted to John Greenough. This was the first United States patent for a sewing machine of which there is any existing record. This machine employed two needles, which were pulled entirely through the cloth by pincers, and the stitch was formed with two threads. The machine was used principally on leather work.

On March 4, 1843, patent No. 2982 was granted to B. W. Bean; on December 27, 1843, patent No. 3389 was issued to G. H. Corliss; and on July 22, 1844, patent No. 3672 was granted to J. Rodgers. In all of these machines a thread-carrying needle was pulled entirely through the cloth by pincers or clamps, forming what is known as a basting or running stitch.

### The Howe and Other Patents

The great epoch of the sewing machine began with Elias Howe and the machine patented by him September 10, 1846, patent No. 4750. In this machine a curved, eye-pointed needle was carried at the end of a pendant, vibrating lever which had a motion simulating that of a pickax in the hands of a laborer. The needle took its thread from a spool above the lever, and the tension on the thread was produced by a spring brake whose semicircular end bore upon the spool, the pressure being regulated by a vertical thumbscrew. The work was held by a row of pins projecting from the edge of a thin metal "baster plate" to which an intermittent motion was given by the teeth of a pinion. Above and to one side of the baster plate was the shuttle race, through which the shuttle carrying the second thread was driven by two strikers, which were operated by two arms and cams on the horizontal main shaft. Although this machine bears little resemblance to the present-day domestic or household sewing machine, it embodied several elements which appear in a modified form in practically all modern lock-stitch machines, viz., a needle with an eye at the point, a shuttle adapted to pass through the needle loop, and an automatic feed.

The next patent of importance in the development of the

sewing machine was No. 6439, granted to Bachelder May 8, 1849, in which a spiked, endless belt passed horizontally around two pulleys and constituted the first practical continuous feed.

Other inventions which contributed much to sewing-machine progress are: Singer patent No. 8294, August 12, 1851, in which a horizontal cloth plate was employed in connection with an overhanging arm carrying a vertically reciprocating eye-pointed needle and a spring presser foot, a horizontally reciprocating shuttle, and an intermittently rotating feed wheel operating through the cloth plate; the patent to A. B. Wilson, No. 9041, June 15, 1852, in which a rotating hook carried the needle loop entirely around a stationary bobbin; and the Wilson patent, No. 12,116, December 19, 1854, in which appeared a feed device comprising a horizontal bar furnished with a serrated surface, which bar was given an up-and-down motion in addition to a forward-and-back motion to feed the goods. This feed, known as the four-motion feed, is present in practically all modern domestic machines.

An average of 500 to 600 applications for patents relating to the sewing machine are filed each year in the United States patent office, of which possibly 400 are granted. They deal chiefly with improvements to existing machines, and especially to "factory" or special machines; probably not more than a dozen are for improvements to domestic or household machines, and these are usually for some small attachment. It is said that the development of the "factory" machine has been at the expense of the demand for household machines, one instance being that cited by a man prominent in the sewing-machine industry, who stated that the rapid advance of the "women's wear" trade has resulted in annually increasing purchases of ready-to-wear apparel where formerly the garments were made in the homes on the domestic machine.

With a capital investment of \$33,000,000 and a yearly output of more than \$28,000,000, the sewing-machine industry now occupies an important place in the United States. These are the figures of the census of manufactures for 1909.

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## THE OXY-ACETYLENE PROCESS IN THE RAILWAY SHOP

From an article by a practical railroad man in the *Railway Age Gazette*, based on personal observation of European practice, it appears that the oxy-acetylene welding and cutting process is used in railroad work to a greater extent in Europe than here. One of the reasons for this appears to be that serious mistakes were made in first introducing the system by salesmen who were not familiar with the requirements in railroad work and the needs of railroad shops, and who made too many claims for it. The result was that the apparatus was often left in unskilled hands and the claims made for it were not realized, mainly because the necessity for systematically instructing the men in the use of the apparatus had not been fully appreciated. The process as used at the Topeka Shops of the Atchison, Topeka & Santa Fe Railroad is said to have given extremely satisfactory results when proper training has been given to the employees. Hence, it is likely that the use of the apparatus will be still further extended in railroad shops when it becomes more fully understood and its limitations are appreciated as well. In some instances, the process, as a whole, has been discredited, simply because the users have not understood its limitations or been able to judge of the class of work for which it was best fitted.

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Careful experiments have been made to determine the amount of change in the height dimensions of the Eiffel Tower, in Paris, due to changes in temperature. Figures for exact temperature changes are not available, but it appears that in a height of about 380 feet the tower increased in length slightly more than  $\frac{3}{8}$  inch in the course of a summer day. The structure of the Eiffel Tower, which rises to a height of about 1000 feet, is very slender. Reduced to a scale of one to 1000, the model would have a height of 12 inches and would weigh one-fourth ounce (?). Thus the iron is quickly heated or cooled, and the experiments made indicate that it is so quickly affected by temperature changes that it responds to the sudden outburst of the sun's rays through a cloudy sky, or to the cooling effect of a shower on a warm day.

# MICROSCOPIC REVELATIONS OF STEEL STRUCTURES\*

A STUDY OF STRUCTURAL CHANGES DUE TO HEAT-TREATMENT

BY E. F. LAKE†

It is only about twenty years ago that the examination of metals under the microscope began. Many different formations of the structure of the crystals were observed, which gave promise of opening up an extensive field for investigation. Several years were required for the examination, study and analysis of these structures. As fast as the results were tabulated and compared a bigger field was opened up, as each formation that the microscope revealed seemed to have a practical application. During the last decade, therefore, the microscope has been brought into practical use in many of the industries engaged in the mechanical working or heat-treatment of the ferrous and non-ferrous metals and alloys.

The steels, in particular, show many changes of structure due to the mechanical and thermal treatment which they receive, so that the microscope has become a very valuable instrument with which to inspect steels. To one who understands what the different formations of crystalline structure denote, the magnified surface reveals the temperature at which the steel was hardened, or at which it was drawn, and the

of treatment to alter their physical properties, so that it has been made possible to foretell what the same chemical combination will do when treated in different ways. Microscopical examination also reveals the mechanical working that the steel has received. That is, it shows whether the metal was cast, hot-rolled, cold-rolled, or whether it was hammer-forged, drop-forged, or slowly pressed into shape as in the hydraulic forging press. It also shows when any of the elements have segregated, as well as any flaws or other imperfections that may exist in the metal. Thus it is covering a wider and wider field every year. As photo-micrographs can easily be made of the surface which is being examined under the microscope, much valuable data is now available in a form in which it can be conveniently preserved.

The majority of metallurgists call this new science metallography, although many call it crystallography. Probably this is because no bigger words could be found. The word metallography is of Greek origin, the first part meaning metal, as it says, and the second part meaning to write; so that literally the word means an account or description of metals. Not all who study metals with the microscope either write about or describe them; hence the word is rather misleading. The science of metals is a broader meaning given the word. While the study of metals with the microscope can well be termed a science, so also can the reduction of ores and their conversion into usable metals. Their mechanical working and heat-treatment can also be classed with the sciences to-day. Thus, even with this broader meaning, the word is unsatisfactory, although constant use may give it the desired meaning. Crystallography is altogether too broad a word, as metals are but a small part of the things in Nature that have a crystalline formation. An easier word, such as micrometal, would fit the case more definitely. The prefix "micro" is of Greek origin and indicates something that is too small to be recognized without the aid of a microscope. It is easily adapted to micrometally, micrometallist, micrometallurgy or any other affix.

In the annealed steel, the constituents that are visible under the microscope are ferrite, pearlite and cementite. Ferrite is pure iron, and when carbon is added to it, each atom of carbon absorbs three atoms of iron, or combines with it. This carbide of iron is called cementite. Pearlite is an intimate mixture of cementite and ferrite, in the definite proportions of 32 parts ferrite to 5 of cementite. Thus it contains 0.90 per cent of carbon. Therefore, when the carbon content of steel reaches 0.90 per cent, a microscopical examination will reveal only pearlite. Below this percentage the surface will show pearlite and ferrite, with the pearlite constantly decreasing until the carbon content becomes nil, and then the surface will be entirely ferritic. Above a content of 0.90 per cent of carbon, the polished surface of the steel will show both pearlite and cementite, until a carbon content of 6.6 per cent is reached, when only cementite will be seen. By using the chart shown in Fig. 1, the carbon content of steel can be calculated from the view obtained with the microscope. As an example, if 70 per cent of the area seen in the microscope shows ferrite and 30 per cent shows pearlite, the vertical line indicating 30 per cent of pearlite is followed upward until it intersects the diagonal line that separates the ferrite from the pearlite. The horizontal line through this point of intersection is then followed to the left to find the percentage of carbon in the steel. In this example it will be 0.270 per cent of carbon.

Figs. 2 to 7, inclusive, are from photographs of the magnified steel surfaces seen under the microscope. In these the pearlite shows black and the ferrite white. But 6 per cent of the area in Fig. 2 is covered with pearlite, which signifies that this steel contains 0.054 per cent of carbon. The black patches are the pearlite and the fine black lines are divisional lines between the different crystals, the steel being composed of tiny crystals that are held together by cohesive force. In Fig. 3 the pearlite covers 12 per cent of the total area, which means that it is a 0.108 per cent carbon steel. Fig. 4 has 17 per cent of its area pearlitic and hence the steel has a car-

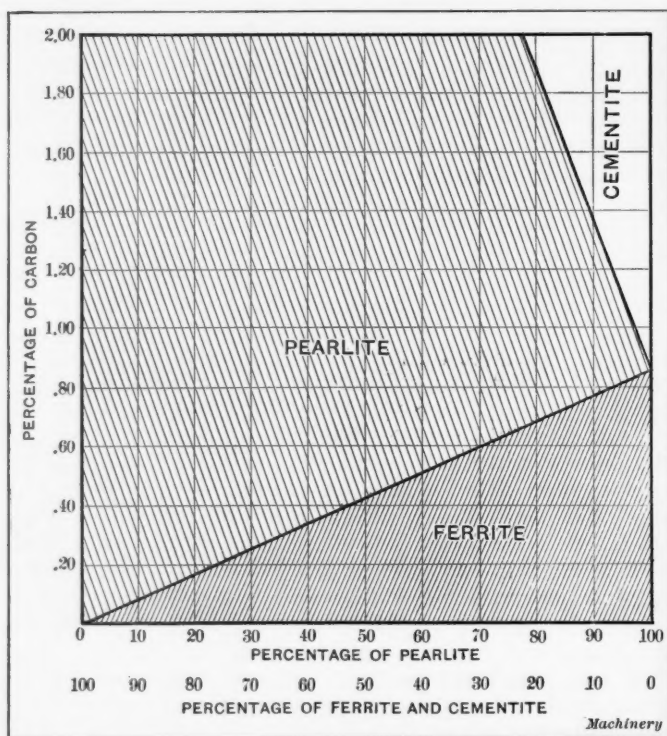


Fig. 1. Chart used to obtain Percentage of Carbon in Steel from Appearance of Micrograph

depth to which the hardness penetrated. It also shows whether the steel was annealed or casehardened, as well as the depth to which the carbon penetrated. The carbon content can be closely judged, when the steel is annealed, and also how much of it is in the graphitic state in the high carbon steels. The quantity of special elements that is added to steel, such as nickel, chromium, tungsten, etc., can also be estimated, when the alloy to be examined has been put through its prescribed heat-treatment. Likewise, the impurities that may be present are clearly seen, regardless of whether they are solid or gaseous substances. As the various constituents of the steel, either common or special, are seen under the microscope in the combinations which they form, and as the structure reveals the real anatomy of the steel, these proximate analyses can be made of more practical value than the ultimate analyses made by the chemist, even though the latter be more accurate as to quantities. Chemistry has become invaluable in the metal industries, yet it must stop with quantitative analyses and the combinations the elements will form. Microscopy goes further by making it possible to see the various formations in metals submitted to different kinds

\* For further information on the metallurgy of steel, see "Natural Alloy Steel," August, 1912, and articles there referred to.

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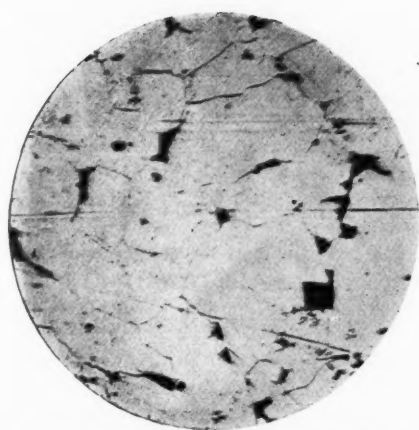


Fig. 2. Ferrite and Pearlite; Carbon, 0.054 Per Cent

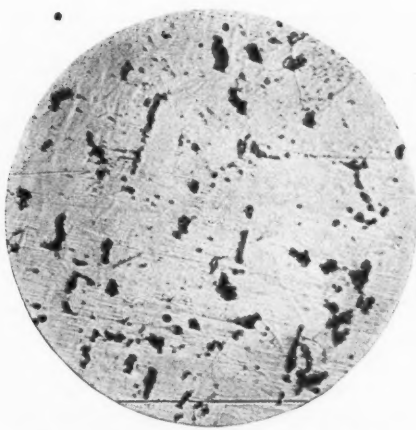


Fig. 3. Ferrite with Pearlite Islands; Carbon 0.108 Per Cent

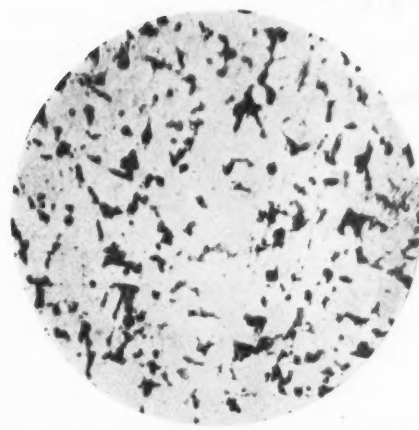


Fig. 4. Ferrite and Pearlite; Carbon, 0.162 Per Cent

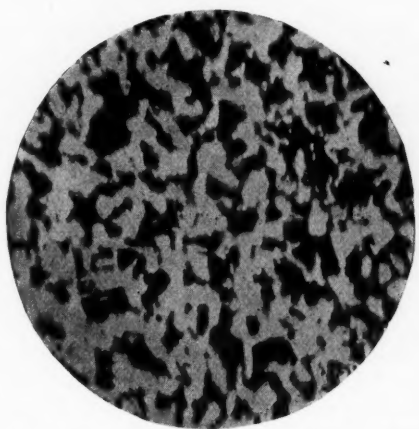


Fig. 5. Pearlite, 28 Per Cent; Carbon, 0.252 Per Cent

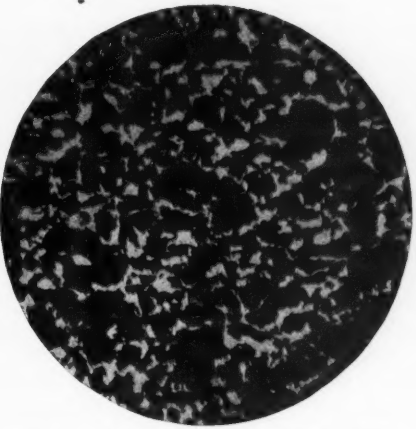


Fig. 6. Pearlite, 60 Per Cent; Carbon, 0.54 Per Cent

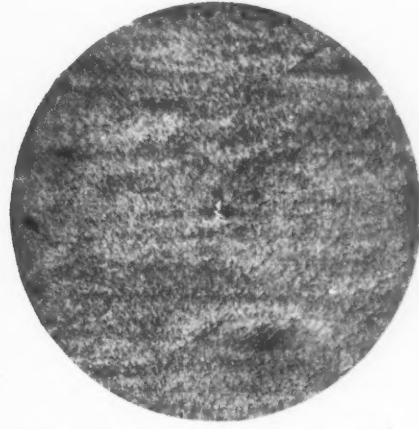


Fig. 7. Pearlite Area predominating; Carbon, 0.90 Per Cent

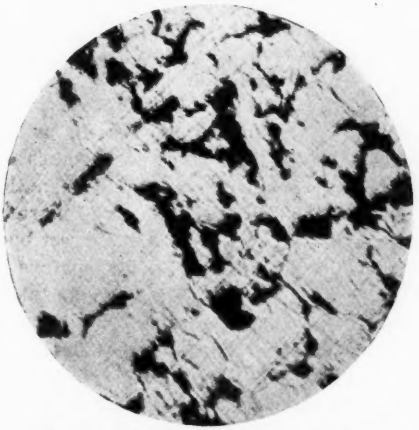


Fig. 8. Photo-micrograph of Cast Steel

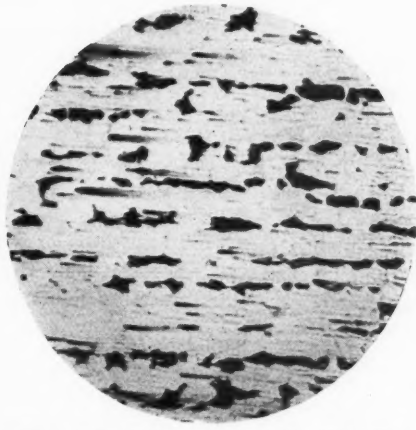


Fig. 9. Steel in Fig. 8 after being Hot-rolled

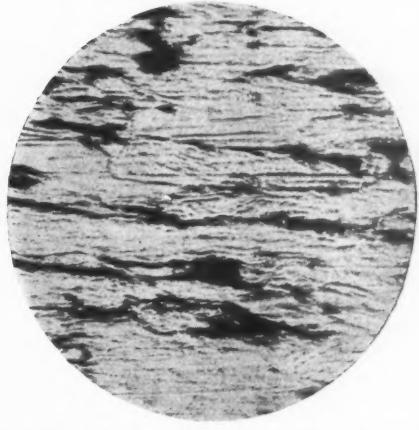


Fig. 10. Steel in Fig. 9 after being Cold-drawn



Fig. 11. Steel quenched at Transformation Point

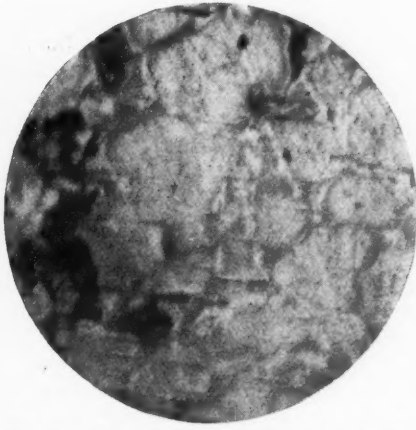


Fig. 12. Steel quenched at 50 Degrees C. (90 Degrees F.) above Transformation Point



Fig. 13. Steel quenched at 100 Degrees C. (180 Degrees F.) above Transformation Point

bon content of 0.162 per cent. Fig. 5 contains 28 per cent of pearlite and the carbon content of the steel is 0.252 per cent. In Fig 6 the pearlitic area is 60 per cent of the total, and thus the carbon content proves to be 0.54 per cent. In the above the percentages of pearlitic area are multiplied by

0.90 to get the carbon content. Fig. 7 shows the pearlite predominating, as in the 0.90 per cent carbon steels. This specimen was treated with a different etching material from the others and hence the pearlite shows gray instead of black. Under the microscope it has the appearance of mother of

pearl, from which its name is derived. When 0.90 per cent of carbon is reached the ferrite has disappeared and each increase, above that point, increases the volume of cementite. Then the carbon content is figured from the percentages of pearlite and cementite.

The use of the microscope for judging the mechanical working received by a steel is shown in the photo-micrographs reproduced in Figs. 8 to 10. Fig. 8 shows a 0.10 per cent carbon steel as it was cast. The pearlite is in irregular patches resembling islands. Fig. 9 shows the same steel after it was hot-rolled. Here the pearlite was pressed out into layers, with the ferrite. Fig. 10 is the same steel after it was cold-drawn. As will be noted, the pearlite islands were still further squeezed out of shape and distorted into thinner and more irregular layers.

In preparing specimens for microscopical examination, they are ground and polished until all scratches are removed and the surface is highly specular. This is done by using abrasives of four or five different degrees of fineness. The different constituents cannot then be clearly seen, if at all, and various methods of etching are resorted to for developing them. This treatment cuts away certain constituents and makes others stand out in relief. These raised portions resemble hills and plateaus, in miniature, which show white from the reflected light in the microscope; while the portions cut away are valleys that receive no light and are thus black. In some cases, constituents are colored by various etching materials and are thus distinguished by their color. The three most commonly used etching materials are picric acid, nitric acid and tincture of iodine. When using, 5 grains of picric acid are dissolved in 95 cubic centimeters of absolute alcohol, and the specimen to be etched is immersed in it 30 seconds; or 10 parts of nitric acid are mixed with 90 parts of alcohol, and the specimen immersed from 10 to 15 seconds; or 1 drop of tincture of iodine is put on each square centimeter of surface to be etched and allowed to stand until the specimen is discolored. Any of these methods will give the steel the appearance shown in Figs. 2 to 10.

Polishing in bas relief will make the pearlite show white and the ferrite black. Thus the white portions in Figs. 2 to 10 would be black and the black areas, or pearlite, would be white. Relief polishing is done with a piece of parchment stretched over a smooth pine block. Rouge is rubbed very hard into the parchment and then rinsed off with running water, until only the rouge is left that was forced into the pores. By rubbing the specimen on this yielding surface, the softer ferrite is ground out below the level of the pearlite. Therefore the reflected light makes the pearlite show bright and the ferrite dark.

The polish attack, which is a combination of etching and polishing, also has the same effect. The same wooden block covered with parchment is used, but in place of the rouge, the parchment is wet with a solution composed of 2 parts of the crystallized nitrate of ammonium to 98 parts of distilled water. The specimen is then rubbed on this until it has been properly etched.

Cementite is a carbide of iron that is not as easily attacked as other constituents, and hence different etching materials have to be used. Immersion for 30 minutes in a 2 per cent solution of oxalate of ammonium will give the cementite a red color. A picrate of soda solution will color cementite brown. When it comes to the higher carbon, cementite steels, it is difficult to distinguish between the cementite and pearlite, pearlite with a slight excess of cementite, and pearlite with a slight excess of ferrite. Thus this special method of etching is necessary.

All of the above methods are good for developing either the ferrite, pearlite or cementite, which are the constituents of the annealed or normal steels only. When we come to the heat-treated steels, these constituents disappear to be replaced by others, and it is in the heat-treated steels that the microscope has been of the greatest practical benefit. Many different constituents are formed as a result of the various degrees of temperature to which steels are submitted for annealing, hardening, tempering and carbonizing, and other etching materials have been found to develop them better. The way in which the metal is affected by each change in temperature has

thus been revealed, and the microscope has placed this branch of the industry among the sciences.

To give the steel the correct temper, it is first necessary to obtain the greatest hardness that the metal is inherently capable of attaining, without a coarsening of the grain. As this leaves the steel quite brittle, it is afterward drawn enough to bring back the desired amount of toughness and ductility. When steel is being heated, it reaches a point where it loses its magnetism. If the heat is measured with a pyrometer, the pointer that indicates the temperature will halt in its upward travel when this point is reached. This is due to a transformation that is taking place in the steel. In other words a new grain structure is being born and the temperature of the metal ceases to rise until the transformation is completed and each crystal has absorbed the required amount of heat to effect this change. In most steels this change of structure occurs below 810° C. (1490° F.), and if the steel is instantly reduced to atmospheric temperature this new grain structure will be preserved. It is the finest grain structure that can be produced in the metal and the steel is as hard as it can be made without coarsening the grain.

If steel is heated above the transformation point and suddenly quenched, as in ice water, a constituent called austenite is developed. The grain is also coarsened, and the higher the temperature, the coarser will be the grain. In Fig. 11 is shown a steel that was quenched at the transformation point. Fig. 12 shows the same steel suddenly cooled from 50° C. (90° F.) above the transformation point; Fig. 13 from 100° C. (180° F.) above, and Fig. 14 from 200° C. (360° F.) above. In the last three illustrations, the austenite structure is revealed. It will be seen that the line of demarcation between the crystals becomes more and more pronounced as the temperature rises, and this indicates a weakening of the metal, as the substance of which these lines are composed is very hard and brittle. In fact, when the temperature is increased very much beyond the transformation point, the internal strains cause microscopic cracks to appear, and these develop into distinct cleavages between the crystals. Thus, to quench steels from above the transformation point has a weakening effect, which is due to the separation of the crystals as shown in the preceding illustrations. Austenite is very unstable and is rapidly changed into other constituents as the steel cools down. Martensite is the constituent that takes its place when the transformation point is reached. When the hardening temperature is too high both austenite and martensite are developed. When the temperature is the correct one, however, only the martensite is seen in the polished surface of the steel. This is shown in Figs. 15 and 16, Fig. 15 being taken from a fine steel and Fig. 16 from a coarse one. The martensite formation resembles a mass of needles that intersect one another in the direction of the sides of an equilateral triangle. All steels that contain more than 0.16 per cent of carbon and have been hardened, will develop the martensitic structure. It is easily retained by any of the hardening and quenching methods; and is the hardest of all the constituents formed in the steel and very brittle. The microscope thus reveals the condition of steels that are martensitic, as the more martensite that is present, the greater will be the degree of hardness of the metal.

One might think that austenite would be harder than martensite, owing to the higher temperatures at which it is developed, but a steel needle will scratch austenite and leave the martensite untouched, when drawn across a steel surface that contains both constituents. In the low carbon steels free ferrite develops with the martensite, and the lower the carbon content, the more ferrite will be present. In large steel pieces, the center is not affected by the heat-treatment as much as the outer portions, and another constituent called troostite is usually intermingled with the martensite. The martensitic structure of hardened steel is changed into troostite by drawing out a part of the hardness; this is done by reheating it to temperatures below 400° C. (752° F.). The troostitic structure is shown in Fig. 17. As the drawing temperature rises from nothing up to 400° C. (752° F.) the martensite gradually disappears and troostite takes its place. Troostite is almost amorphous and generally appears in irregular areas that are dark colored. It is sometimes slightly granular. The white

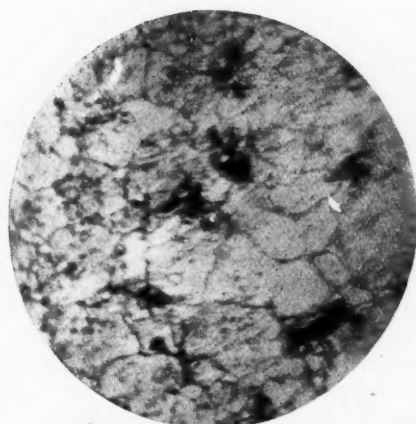


Fig. 14. Steel quenched at 200 Degrees C. (360 Degrees F.) above Transformation Point



Fig. 15. Martensite Structure in a Fine Grained Steel

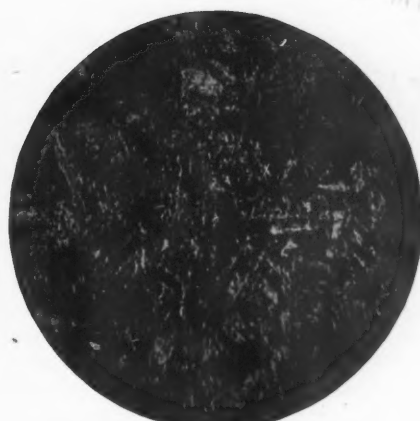


Fig. 16. Martensite Structure in a Coarse Grained Steel



Fig. 17. Troostite Structure; Steel drawn at 250 Degrees C. (482 Degrees F.)



Fig. 18. Temper drawn at 400 Degrees C. (752 Degrees F.); Osmondite Structure

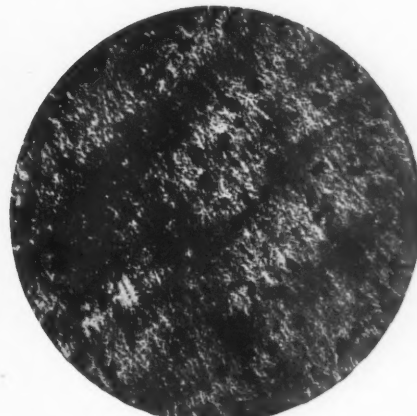


Fig. 19. Temper drawn at 550 Degrees C. (1022 Degrees F.); Sorbite Structure



Fig. 20. Quenching Oil too Hot; Troostite and Martensite Structure

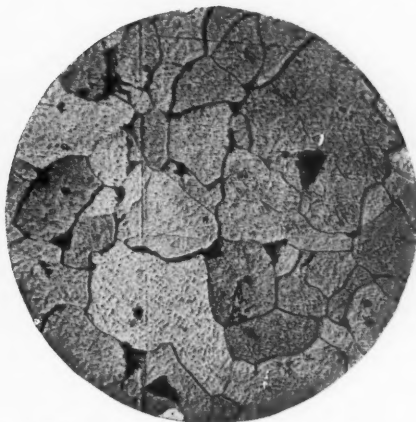


Fig. 21. Crystalline Structure of Overheated Steel

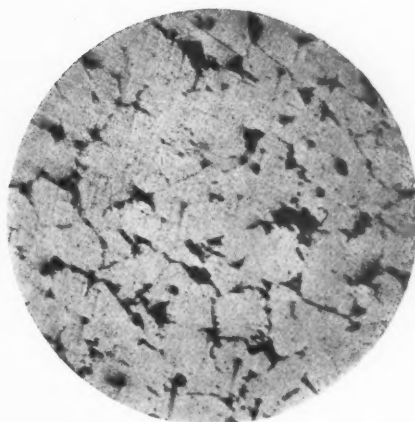


Fig. 22. Steel of Fig. 21 restored by Correct Heat-treatment



Fig. 23. Burnt Steel showing Cracks between Crystals

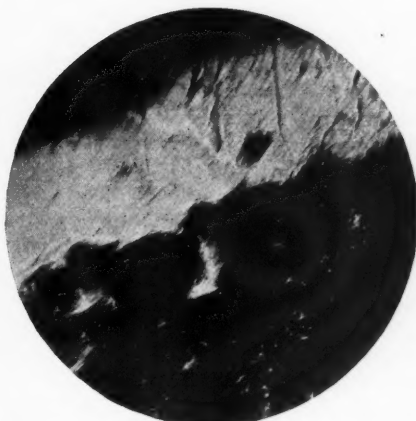


Fig. 24. Casehardened Steel showing Unequal Carbonization

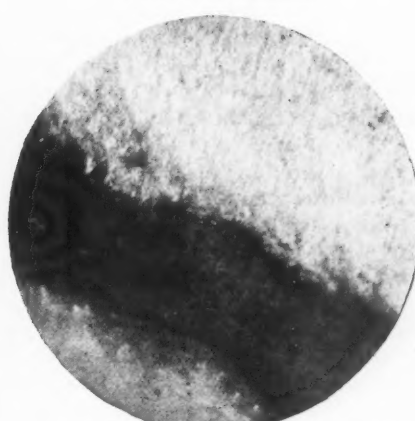


Fig. 25. Crack between Carbonized Shell and Core

places in Fig. 17 are needles of martensite, which remained in the steel because the drawing temperature was not high enough to convert it all into troostite. Thus it is called a troosto-martensitic steel. The temperature at which the metal was drawn can be judged from the amount of each constituent

that is present. When a drawing temperature of about 400° C. (752° F.) is reached the martensite has all disappeared and the steel surface has the appearance shown in Fig. 18. This has been named osmondite, but as it is the boundary line between troostite and the next constituent which is developed by

higher drawing temperatures, it is a question as to there being any definite constituent that can always be located and named. In this illustration, the lighter areas very much resemble the birth, or beginning, of the sorbitic structure which follows the troostitic.

When the drawing temperature is approximately between 400° and 800° C. (752 and 1472° F.) the constituent called sorbite is developed, which reaches its maximum at 600° C. (1112° F.), and the polished surface will then be entirely sorbitic. The sorbitic structure is shown by Fig. 19. Hardened steels that have been reheated for tempering, to between 400° and 600° C. (752 and 1112° F.) will show both troostite and sorbite, and these are called troosto-sorbite steels. The amount of each constituent that is present will show the temperature at which the steel was drawn. With the drawing temperature from 600° to 800° C. (1112 to 1472° F.) both sorbite and pearlite can be seen, while above 800° C. only the pearlite, ferrite and cementite, of the thoroughly annealed steels, are visible.

The chart shown in Fig. 26 illustrates how the various constituents overlap each other and how the use of the

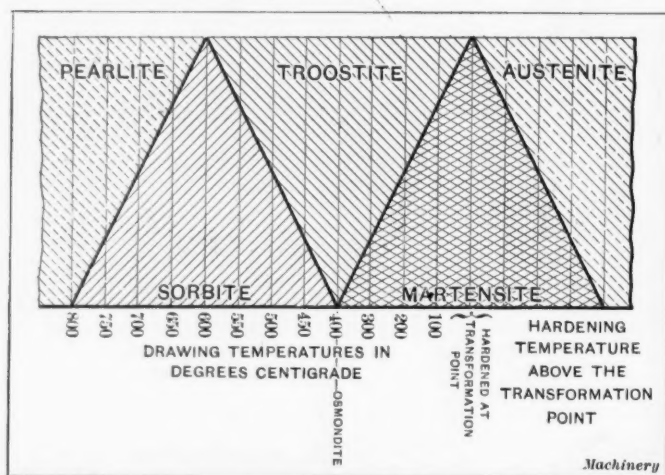


Fig. 26. Constituents seen in Microscope and their Relation to Hardening and Drawing Temperatures

microscope enables one to judge the drawing temperature from the amount of each constituent that is present. Sorbite is softer and tougher than troostite and troostite is softer and tougher than martensite. Pearlite is softer than any of the others, while austenite is more brittle. Thus, as these various constituents intertwine with one another like the branches of trees in a forest, they impart to the steel the hardness, toughness, ductility, strength, or other properties in the exact proportion to the amount of each constituent that is present.

In etching specimens to develop the constituents of hardened and tempered steels, very good results are obtained with sulphurous acid that is composed of 4 parts sulphur dioxide to 96 parts of distilled water. The specimens are immersed in this, face upward, and removed as soon as the polished surface is frosted. This takes from 7 seconds to 1 minute. They are then rinsed with water, as usual, and dried with alcohol. Very thin layers of iron sulphide are deposited on the different constituents in different thicknesses, and this gives them different colors. Austenite remains a pale brown; martensite is given a pale blue and deep blue and brown color; troostite is made very dark; sorbite is uncolored; cementite exhibits a brilliant white; and ferrite is made dark brown. In ferrite and pearlite steels, the ferrite is instantly pitted without developing the crystalline junction and hence is hard to distinguish from finely divided pearlite. Austenite can also be made white by 10 per cent of hydrochloric acid in solution. Martensite can be brought out by the picric, nitric or hydrochloric acid solutions or by the polish attack. Troostite can be made white with tincture of iodine and black with the picric acid solution or the polish attack. Osmondite is etched the most deeply with hydrochloric or sulphuric acid solutions. Sorbite shows white when etched with picric acid.

A few of the imperfections found in steels are illustrated by Figs. 20 to 25. Fig. 20 shows a steel that was quenched at the correct temperature, but the oil in which it was quenched was too hot and, hence, it was not cooled down sud-

denly enough. The light areas are martensite and the black ones are troostite. This means that the steel is not uniform in hardness, as the troostite produces spots that are softer than the martensite areas. This condition can only be cured by a reheating and hardening. In Fig. 21 is shown a steel that was overheated. The grain was thus coarsened, and the heavy lines of demarcation between the crystals are a hard and brittle substance that weakens the cohesive force which binds them into a solid mass. This condition can be corrected by re-heat-treating the steel, and Fig. 22 shows this same steel after it has been correctly heat-treated. The cohesive force has been restored to its former power and the grain has been refined. A steel is shown in Fig. 23 that was heated to a considerably higher temperature than that in Fig. 21 and the internal strains, due to expansion and contraction, caused distinct cracks to appear between the crystals. These are shown by the black areas. Such a condition can only be cured by a remelting and working. This shows what is called "crystallization" by some and "burnt steel" by others. It is difficult, however, to draw a line between overheated steel that can be restored by heat-treatment and burnt steel that must be remelted. The microscope enables us to reach a much more definite conclusion on this point than any other known method of examination or testing.

In Figs. 24 and 25 are shown steels that were carbonized. In Fig. 24, the white streak and spots are almost pure iron, or ferrite, while the black areas are saturated with carbon. This means that the carbon did not have a uniform penetration, and either the carbonizing material was of a very poor quality or the steel was not heated to the proper temperature during the carbonizing operation. In Fig. 25 the black streak represents a crack that developed between the carbonized outer shell and the core. In the heat-treatment after carbonizing, cracks like this can be caused by heating the steel too rapidly and then quenching it before the heat has penetrated to the center of the piece. They can also be caused by the use of incorrect temperatures during the carbonizing operations, or of carbonaceous materials that are not rich in carbon. Either of these conditions might cause a decided demarcation line to exist between the outer shell and the core, and this would mean that the high percentage of carbon in the outer shell came to an abrupt end at this line. Whereas, in properly carbonized steel, the carbon percentage is highest at the outer surface and gradually tapers down to the percentage contained in the core. Then no sharp dividing line exists between the carbonized shell and the core, and the expansion and contraction strains are equally distributed throughout the piece.

There are many other things that the microscope reveals about steels and it is also quite extensively used on steel castings, cast iron, sintering materials, non-ferrous metals and other products. It is really remarkable how much knowledge has been gained about a science that is so new, and how this knowledge has been applied to practical everyday work in such a short time. With all that has been done, however, there is still room for more development along this line, the principal need at present being standardization that will bring order out of the chaos previously existing. For instance, several hundred different magnifications are used in the examinations, but if certain standard sizes were adopted this number could be reduced to about twelve, and specimens or micro-photographs could be compared with much profit to both the worker and the student. With but few exceptions, the meaning of the names of constituents have been well defined by different societies during the past year, and the confusion that previously existed on this score has been overcome. A few new words were also coined to better express certain things in this connection and we can be thankful that the coiners made them simple and easy to pronounce.

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A patent has been granted to Mr. C. F. Marston of Great Neck, N. Y., for a signal device which is so connected with the brake mechanism of an automobile that the signal is operated whenever the brakes are manipulated. The object of the device is to warn an automobile approaching another from the rear, of the fact that the automobile in the front is applying its brakes to reduce its speed or stop, and, in this way, to prevent rear-end collisions.

## EFFICIENT PRODUCTION DEPENDENT ON UP-TO-DATE EQUIPMENT

BY A. A. PEEBLES\*

In these days of keen competition it is essential to the success of any engineering establishment that its equipment should be of a nature to permit of rapid and efficient production. In order that this desideratum may be realized the machinery employed must be of the most modern type, and of a character adapted to the requirements of the particular line of manufacture which is to be undertaken.

Although the importance of these factors must be evident to all engineers, it is relatively seldom that the required conditions are realized in practice. Any engineer who is in close touch with modern machine tool developments, and whose business gives him the *entree* to a large number of different machine shops, cannot help but realize how very few there are in which the equipment does not permit of considerable criticism. Sometimes it will be found that the tools employed are out-of-date on account of false economy on the part of the management, which grudges the capital expenditure involved in replacing obsolete machines by those of improved design. Sometimes it may be observed that, while the plant is quite modern, it is not of the type best suited to the conditions prevailing in the particular factory in which it is installed. Sometimes it is the general lay-out which permits of improvement. And it is the rare exception that a machine shop is found which realizes the ideal that the expert knows to be within the bounds of practical possibility.

The reason for this is fairly obvious, and is, in itself, productive of speculation. This is an age of specialization, and before a man can occupy a managerial position in a shop manufacturing steam engines, or gas engines, or agricultural machinery, he has to have many years of experience solely in that particular line. And, having attained such a position, the exigencies of his business usually demand the whole of his time. He is frequently a good engineer, with a fair general knowledge of his profession and an exhaustive knowledge of his own particular groove. But, while his knowledge of machine tools is frequently considerable, it is rarely any where nearly complete.

To-day the tendency is toward standardization, and standardization means the increasing introduction of repetition work. The day of the general engineering shop is passing, and giving place to factories which make only one class of articles. The result of this is that the old-style shop equipment, consisting of engine lathes, planing machines, slotting machines, drills and shapers, has also given place to the more specialized machine tool, and every day, figuratively speaking, some enterprising machine tool manufacturer puts on the market a new design especially adapted to some particular process. To-day, instead of the general machine used for many purposes, we have the special machine which will perform a special operation with a maximum of efficiency, and in order to keep track of all such tools which are annually placed on the market it is necessary for a man to devote his whole attention to a study of the subject.

This is impossible for the manager of a large engineering works, and it is equally impossible for any of his staff, who all have other duties which demand their attention. It therefore follows that when a new plant is being installed, the machines selected, though usually adequate, are frequently not the very best which could be had for the purpose. The manager usually has the last word in selecting new tools, and not being in intimate touch with the latest practices in machine design, the chances are against his getting the equipment suited in the best possible way to his requirements, while sometimes exceedingly poor judgment is discernible in the choice of tools.

A number of instances of the latter have come to the writer's notice, some of which were very marked. One was in a large automobile shop in London, England, which carried out a very big repair business, but did little manufacturing. Included in the machine shop equipment was an expensive fully-automatic bevel planing machine, for cutting the teeth on crown, differential and other bevel gearing used in auto-

mobiles. The tool was eminently adapted for the production of a large number of wheels of one pattern, and would have been excellent for a large producing factory working on the standardization principle. But for the odd jobs of a repair shop it was quite unsuitable on account of the time occupied in setting it up. There are semi-automatic machines which, though slower in operation, are much more easily prepared for cutting any given wheel, and are, therefore, far more suitable for the requirements of a shop doing the kind of work undertaken by the one in question.

In this same works there was a large high-speed sliding, surfacing, and screw-cutting lathe capable of swinging twenty-four inches over the bed, and big enough to handle work three times the size of anything connected with an automobile. It was useless as a lathe, so the slide-rest had been dismantled and a vise arrangement fixed up for holding heavy bar steel, while the mandrel had been equipped with a circular saw for cutting the latter. It was the case of a \$1200 machine doing the work which a \$500 one would have done more efficiently.

Another case was that of a London firm which had a world-wide reputation as makers of high-class steam fittings, and which enjoyed a large share of the patronage of the British Admiralty. Two years ago this firm went into liquidation, the cause being directly traceable to poor equipment. The shops in this case contained some 300 machines, and produced valves and steam fittings of standard designs in large quantities. It was a case in which machines suitable for repetition work were absolutely essential for efficient production, and yet out of the 300 tools only six were adapted for such work: four small wire-feed automatic capstan lathes, and two larger machines fitted with chasing saddles.

Even in the biggest concerns one finds a similar state of things. One of the largest Tyneside shipyards, possessing a plant valued at over \$5,000,000 and employing 4000 hands, has gone for several years without paying any dividend, and while this may be due in part to other causes, it is certainly largely attributable to the fact that the equipment employed is not up-to-date, and it cannot therefore compete with other more modern plants. In the shops in question there are a number of excellent and modern tools, but there are also far more old ones, which should have been scrapped as soon as developments of tool steel rendered heavy cutting practicable.

These are just a few instances. They could be multiplied indefinitely by any engineer who has had the opportunity of studying the subject. And the conditions outlined are not confined to the British Islands. They are found in even more marked preponderance in Canada, and although the United States exhibits generally a more progressive and judicious spirit, it is by no means free from similar cases.

There are two factors causative to the existence of such conditions. The first is lack of progressive policy, and the second lack of expert knowledge in machine tool developments. The former is the cause of nearly all glaringly inefficient equipments, while the latter results in an *ensemble* which, though often fairly effectual, permits of improvement. The first can be remedied only by scrapping every tool as soon as a new one of marked superiority is brought out. The latter can be mitigated by a careful study, on the part of the management, of technical journals dealing with machine improvements, and by examining the new catalogues of the leading machine tool manufacturers.

There are thirty-two firms known to the writer which specialize to a greater or less extent in the manufacture of turret and capstan lathes. All are firms of standing, and produce work of the highest class, and each makes a number of different designs of tools. In addition, there are numerous smaller firms doing similar work, and the total number of different types of this one class of machine at present on the market is enormous. Each type and each make differs in some particular from all the rest. Some are preeminent for one class of work, some for other classes. And whatever class of work is required, there is probably one machine which will do it just a little better than any other machine. But it takes a man who has had wide experience in the machine tool business to put his finger on that particular one. The same thing applies to milling machines, to boring and facing machines, and to every class of tool found in the modern workshop, while in

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addition there are scores of special machines designed solely for one particular operation and class of work, such as crank-shaft lathes, railway axle lathes, turbine boring machines, and many others.

Among the latter is one particular tool which has been on the market now for some two years. It is designed for boring automobile cylinders, and where repetition work is required, it is perhaps the best tool for the purpose. It consists of a central column carrying three working spindles, each of which is provided with automatic feed. A circular table revolves about this column, and the cylinders are held to the table by jigs, accommodation being provided for the mounting of four cylinders at one time. Cylinder No. 1 is then brought under spindle No. 1, where it is rough-bored. It is then swung round to spindle No. 2, where it is rough-reamed, the same movement bringing cylinder No. 2 under spindle No. 1, where it is bored while the first one is being reamed. The next movement of the table brings cylinder No. 1 beneath spindle No. 3, where it is finish-reamed, cylinders Nos. 2 and 3 being simultaneously rough-reamed and bored, respectively. At the following movement cylinder No. 1 can be removed, and replaced by a fresh one, while cylinders Nos. 2, 3 and 4 are undergoing their various operations in the cycle. But although this machine is within the reach of all, one still finds manufacturers doing the work on single- and double-spindle boring machines of the old type, and sacrificing time and profits in the process, simply because they are not versed in modern machine tool practice.

The whole trend of development in modern machine shop methods tends to the evolution of the machine tool expert: The man who has a practical knowledge of latter-day improvements, and who has made a study of the machinery market. Such a man, after due study of the requirements of a particular case, would be in a position to insure an equipment of a nature suited to the need of that case, and the errors of judgment which are the cause of such serious losses would be abolished. But, apart from this, a good deal could be done to mitigate existing conditions by a more careful study, on the part of those in control of engineering establishments, of the technical press, and by paying more attention to the catalogues of the machine tool trade.

\* \* \*

#### UNIT MACHINE CONSTRUCTION

The unit system of machine construction is becoming more and more common especially with machine tools. It has several advantages. In the first place the separate units can be made and assembled in separate departments, each department being arranged to suit the condition of work, whether light or heavy, etc. In the second place the units can be independently tested, and if defects develop they are corrected without seriously blocking the output of finished machines. If a complete machine is tested and found faulty it is held until a minor defect, perhaps, is found and repaired. The same defect found in a separate unit would have been corrected before reaching the assembly floor and thus no delay at this stage of output would have occurred. The third advantage is that unit construction encourages interchangeable manufacture—in fact makes it necessary to a certain extent. The units can be withdrawn from the machine by the user to be repaired in his own plant or shipped to the home shop. Another feature of unit construction of importance to makers of special machinery having the same general characteristics is that unit gear boxes, headstocks, etc., may be used in special machines. Thus the cost of special machinery can be reduced because of the possibility of manufacturing some of the parts.

\* \* \*

One of the very best types of floor, incidentally rather an expensive floor, is the creosote or hardwood block laid end grain. The Aberthaw Construction Co. of Boston in a recent investigation found that several paper mills have used these with considerable success. The floor has the advantage of resisting water conditions, of standing up under the hardest trucking, of being a resilient, noiseless floor and one which can be kept very clean. For practical use in this country the creosoted block is almost the only one used. Where these are laid on a concrete floor, the best practice is to dip them in tar and stick them down to the floor, then grout between the blocks with cement. A three-inch block has sufficient depth.

#### COMPOSITION OF NON-FERROUS ALLOYS\*†

The Bureau of Steam Engineering of the U. S. Navy Department issued specifications in 1910 for materials to be supplied to the navy. As the compositions of these materials are based on the most approved practice and on thorough experience with metals of this kind, they should be of value to every one who has to deal with metal alloys. The most important points of the specifications published have, therefore, been collected and are published in the accompanying Data Sheet Supplement. The essential properties required of metals of this kind by the Navy Department are given in the following.

##### Properties Required of Non-ferrous Casting Materials

The properties required in the most important of the non-ferrous casting materials are as follows:

**Gun bronze:** The minimum tensile strength must be 30,000 pounds per square inch; the minimum yield-point, 15,000 pounds per square inch; and the elongation in 2 inches, 15 per cent.

**Manganese bronze:** The minimum tensile strength must be 60,000 pounds per square inch; the yield-point, 30,000 pounds per square inch; and the elongation in 2 inches, 20 per cent.

**Monel metal:** The minimum tensile strength must be 65,000 pounds per square inch; the yield-point, 32,500 pounds per square inch; and the elongation in 2 inches, 25 per cent.

**Phosphor-bronze:** The minimum tensile strength must be 40,000 pounds per square inch; the yield-point 20,000 pounds per square inch; and the elongation in 2 inches, 20 per cent.

##### Specifications for Rolled Plates, Sheets, Shapes, etc.

The principal requirements of the more important non-ferrous materials used for rolled plates, sheets, shapes, etc., are as follows:

**Copper:** Ultimate tensile strength, 30,000 pounds per square inch; elongation in 2 inches, 25 per cent.

**Muntz metal:** Tensile strength, 40,000 pounds per square inch; elongation in 2 inches, 25 per cent.

**Phosphor-bronze:** Tensile strength, 50,000 pounds per square inch; elongation in 2 inches, 25 per cent.

**Naval brass, 1 inch and below:** Tensile strength, 62,000 pounds per square inch; elongation in 2 inches, 25 per cent.

**Above 1 inch:** Tensile strength, 60,000 pounds per square inch; elongation in 2 inches, 28 per cent.

**Manganese bronze, 1 inch and below:** Tensile strength, 72,000 pounds per square inch; elongation in 2 inches, 28 per cent. **Above 1 inch:** Tensile strength, 70,000 pounds per square inch; elongation in 2 inches, 30 per cent.

**Monel metal, 1 inch and below:** Tensile strength, 84,000 pounds per square inch; yield-point, 47,000 pounds per square inch; elongation in 2 inches, 25 per cent. **Above 1 inch:** Tensile strength, 80,000 pounds per square inch; yield-point, 45,000 pounds per square inch; elongation in 2 inches, 28 per cent.

In the case of Muntz metal, phosphor-bronze, naval brass, and manganese bronze, the yield-point should be one-half of the ultimate tensile strength specified.

##### The Tensile Strength of Piping

The tensile strength of piping should be as follows: Brass piping, 7000 pounds per square inch; copper piping, 6000 pounds per square inch; Benedict nickel piping, 14,000 pounds per square inch; and Monel metal piping, 20,000 pounds per square inch. Brass and copper pipe should not be tested, however, beyond 1000 pounds per square inch, and Benedict and Monel metal pipes should not be tested beyond 2000 pounds per square inch.

\* \* \*

The greatest problem of today is not how to increase efficiency, but how to distribute equitably the products of the increased efficiency.

\* With Data Sheet Supplement.

† The following articles on this and kindred subjects have previously been published in MACHINERY, April 1911, engineering edition, "Aluminum Alloys"; February, 1911, engineering edition, "Common Defects in Metal Alloys"; August, 1909, engineering edition, "Bearing Metals"; May, 1909, engineering edition, "Anti-friction Alloys for Bearings"; October, 1903, engineering edition, "The Study of Alloys Suitable for Bearing Purposes." See also MACHINERY's Reference Series No. 11, "Bearings."

# GRAPHICAL METHOD OF DETERMINING MOMENTS OF INERTIA

## MOHR'S METHOD OF GRAPHICAL DETERMINATION SIMPLY EXPLAINED

BY R. KRAUS\*

In all problems of mechanical design, the question of stresses occurs. If the material is subject to bending or torsional stresses, the determination of the amount of such stresses makes it necessary to first determine the moment of inertia of the section under consideration. For some of the simpler forms of sections, analytical methods solve the problem readily, but many of us know how long it takes to arrive at the result, where complicated sections are involved, and how many chances there are for errors to be made in the calculations. Various graphical methods have been developed for the solution of this problem. The writer is using Mohr's method which, in his opinion, is the simplest of all. This method is not original with him but has not, to his knowledge, been published in English, and it is given here with the hope that its advantages may be made of more general value.

Many readers will welcome a complete derivation of the method, and all the fundamental principles will be given instead of assuming that each reader will review them in some text on mechanics. In Fig. 1, let us assume a force  $P_1$  in pounds and a pole  $O$  in the same plane and at a distance  $p_1$  in inches. The moment  $M_1$  is given by the following equation:

$$M_1 = P_1 p_1, \text{ inch-pounds.} \quad (1)$$

Now the product  $P_1 p_1$  can be represented by the area of a rectangle, assuming  $P_1$  as the base and  $p_1$  as the height. Another force  $P_2$  has a moment relative to the pole  $O$  of

$$M_2 = P_2 p_2, \text{ inch-pounds.} \quad (2)$$

To compare these two moments, we shall express them by a length only. For this purpose, we treat the rectangles representing the moments in a purely geometrical sense, changing both rectangles to a common base  $H$ , keeping the areas the same, and letting the heights of the rectangles be  $p_2$  and  $p_1$ , Fig. 2. Then,

$$H p_1 = P_1 p_1 = M_1 \quad (3)$$

$$H p_2 = P_2 p_2 = M_2 \quad (4)$$

Thus by using  $H$  as the base unit, we can compare the moments by simply comparing the lengths  $p_2$  and  $p_1$ . During the remainder of the article we shall call  $H$  the "base of the moments." We shall make an application of this principle to determine the moment of the force  $P$  relative to the pole  $O$  in

we see that the distance between two points of intersection of the two sides of the polygon, on a line parallel to the line of action of the force, represents the moment of the force about any point in this line to some scale. This theorem will be used in what follows.

We can now undertake the construction for finding the moment of inertia. To find the moment of inertia of an area relative to the axis  $X-X$ , Fig. 4, divide the area under con-

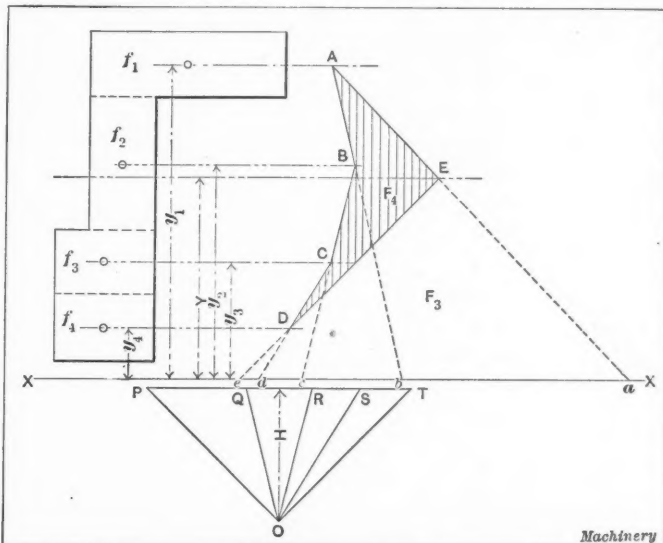


Fig. 4. Derivation of Mohr's Method for Graphical Determination of Moment of Inertia

sideration into a number of small strips whose areas are  $f_1, f_2, f_3$ , etc. Find the area and center of gravity of each strip and consider the area of each strip as a weight. Imagine these weights suspended about a line through their centers of gravity and parallel to the axis  $X-X$ . We shall now draw the polygon of forces. For that purpose, draw any line  $PT$  parallel to the axis  $X-X$  and lay out on it to some convenient scale, the areas  $f_1 = PQ, f_2 = QR$ , etc. Then choose a pole  $O$  at a distance  $H$  from the line  $PT$  and connect  $O$  with  $P, Q, R, S$  and  $T$ . Then

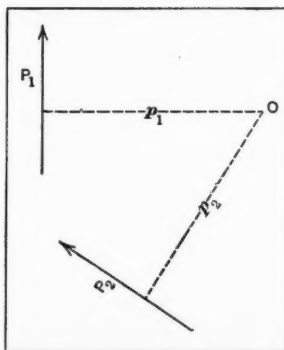


Fig. 1. Diagram of Moments about Pole  $O$

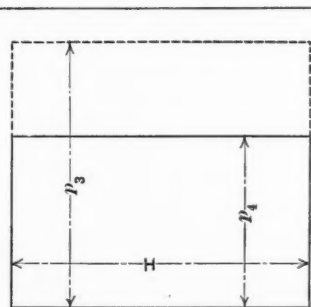


Fig. 2. Diagram explaining "Base of Moments"

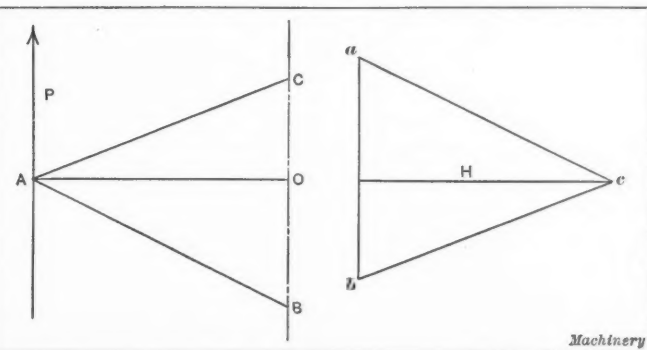


Fig. 3. Diagram showing Method of determining Moment of Force  $P$  about Pole  $O$

Fig. 3. Choose any point  $A$  in the line of action of the force  $P$  and draw a line through  $O$  parallel to  $P$ . Draw any other line, such as  $ab$ , parallel to the last line drawn, and lay out a length  $ab$  on it to represent the force  $P$  to some convenient scale. Choose also some point  $c$  as a pole, at a distance  $H$  from  $ab$ . Join  $ca$  and  $cb$ . Now from  $A$ , draw lines  $AB$  and  $AC$  parallel to  $ac$  and  $bc$ , respectively. Compare the triangles  $abc$  and  $ABC$ ; since the sides are parallel, the triangles are similar and we have:

$$ab : H = CB : AO$$

$$ab \times AO = H \times CB$$

But  $ab \times AO$  represents the moment of the force  $P$  about the pole  $O$ . Thus, if we consider  $H$  as the base of the moment, the length  $CB$  will also represent that moment to some scale. Thus

construct the polygon  $A, B, C, D, E$  in the usual manner. As previously shown, the length between the intersection of two sides of this polygon with the axis, such as  $X-X$ , represents the moment of the force about that axis. Thus, the moment of  $f_1$  about  $X-X$  is equal to  $abH$  to the proper scale. Then, letting  $M_1, M_2$ , etc., be the moments of  $f_1, f_2$ , etc., about  $X-X$  we have:

$$M_1 = abH \quad (5)$$

$$M_2 = bcH \quad (6)$$

Now let  $y_1, y_2$ , etc., be the distances of the centers of gravity of the respective areas  $f_1, f_2$ , etc., from the axis  $X-X$ . Their moments can also be expressed as the product of the weights of the strips and the distances of their centers of gravity from the axis. Thus:

$$M_1 = f_1 y_1 \quad (7)$$

$$M_2 = f_2 y_2 \quad (8)$$

\* Address: Care of Engineering Works of Canada, Ltd., Montreal, Canada.

But from Equations (5) and (6)

$$M_1 = abH = f_1 y_1 \quad (9)$$

$$M_2 = bcH = f_2 y_2 \quad (10)$$

Suppose that  $F$  is the total area of the section  $= f_1 + f_2 + f_3$ , etc., and that  $Y$  is the distance of its center of gravity from the axis  $X-X$ , and let  $M$  be the total moment. Then:

$$M = f_1 y_1 + f_2 y_2 + f_3 y_3 + \text{etc.} = \Sigma f y \quad (11)$$

$$M = abH + bcH + \text{etc.} = aeH \quad (12)$$

Now consider the triangles  $POT$  and  $eaE$ . Since the sides are parallel by construction

$$ae : Y = TP : H$$

$$\text{or} \quad aeH = TPY = Y\Sigma f = YF.$$

Hence, we have from Equation (12)

$$M = YF \quad (13)$$

Thus  $Y$  is the distance of the center of gravity of the section from the axis  $X-X$ , or a line through  $E$  parallel to  $X-X$  passes through the center of gravity of the section.

The moment of inertia of the area relative to the axis  $X-X$  is expressed by the quantity  $\Sigma f y^2$ . Calling the moment of inertia  $I$ , we have:

$$I = \Sigma f y^2 = \Sigma (fy) \Sigma y = Hae \Sigma y \quad (14)$$

by substitution from (11) and (12).

Now consider the triangle  $Abd$ . Here  $ab$  is the base and  $y_1$  is the height; thus  $aby_1$  = twice the area. Similarly for  $bcy_2$ , etc. Call  $F_2$  the area of the polygon  $ABCD$ . Then:

$$ab y_1 + bc y_2 + \text{etc.} = 2F_2.$$

$$\text{or} \quad ae \Sigma y = 2F_2. \quad (15)$$

Substituting this value in Equation (14):

$$I = 2HF_2. \quad (16)$$

Let  $I_0$  be the moment of inertia of this area about a line through its center of gravity,  $Y$  being the distance of its center of gravity from the axis  $X-X$ . Then:

$$I_0 = I - FY^2. \quad (17)$$

and

$$FY^2 = (FY)(Y) = \Sigma (fy)Y = HaeY \quad (18)$$

Consider the triangle  $eaE$ . Let its area be  $F_3$ .

$$aeY = 2F_3. \quad (19)$$

Thus from (18) and (19)

$$FY^2 = 2HF_3. \quad (20)$$

$$\text{Then } I_0 = I - FY^2 \quad (17)$$

$$= 2HF_2 - 2HF_3 [\text{from (16) and (20)}]$$

$$= 2H(F_2 - F_3)$$

$$= 2HF_4. \quad (21)$$

$F_4 = F_2 - F_3$ ; and from an inspection of the figure we see that  $F_4$  is the area of the polygon  $ABCDE$ . This equation can now be expressed as follows: "The moment of inertia of an area about an axis through its center of gravity is represented by the product of the area of the polygon of forces and twice the base of the moment." This gives us a key to the following simple construction for finding the moment of inertia. Make  $H$  equal to half the length  $PT$  which represents the area of the section under consideration to some convenient scale. Then the moment of inertia is represented by the product of the area  $F$  and the area  $F_4$  of the polygon of forces. An inspection of the derivation shows that the result obtained from the construction is dependent only on the scale to which the area of the section has been drawn. The scale which we choose in laying out the polygon is immaterial, since if the area of the section is shown full size, the area of the polygon of forces is also shown full size. If, however, the area is not drawn full size, the actual moment of inertia is obtained by multiplying the moment of inertia derived from the drawing by  $X^2$ , where  $X$  is the scale used.

**Example:** Suppose Fig. 5 represents (reduced size) a section whose moment of inertia we wish to obtain about its neutral axis. The section is divided into seven small areas whose centers of gravity are readily found. The areas of these are set off along the line  $PW$  to a scale of  $\frac{1}{2}$  inch = 1 square

inch. The point  $O$  is chosen at a distance from this line of  $\frac{F}{2}$

to the same scale, and joined with the points  $PQRSTUVW$ . Then the polygon of forces  $F_4$  is constructed. The area of this polygon is determined either mathematically or with a planimeter, and is found to be 12 square inches. The sum of the small areas of the section  $F$  is 17.41 square inches. Thus the moment of inertia is  $17.41 \times 12 = 208.92$ . Also the neutral axis of the section passes through the point  $M$ , from which we find its ordinates  $e_1 = 5.8$  and  $e_2 = 5.2$ .

\* \* \*

The bill introduced into the House of Representatives asking for an appropriation for the preliminary work of building a dam or jetty some two hundred miles long, reaching out into the Atlantic from the coast of New Foundland, is not especially creditable to its advocate. As is well known, the modest purpose of the congressman who introduced the bill is to divert the Gulf Stream so as to bring about great

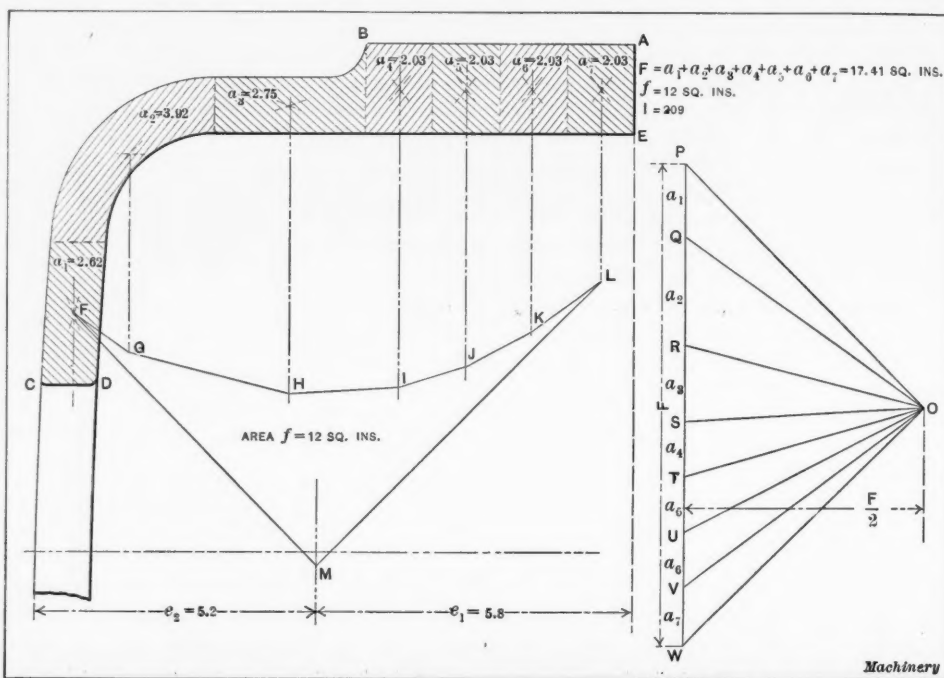


Fig. 5. Application of Mohr's Method in determining Moment of Inertia of the Section ABCDE

climatic changes to the advantage of the United States and Greenland; incidentally these advantages would be accompanied by a "slight" change in climatic conditions in north-western Europe, making the British Islands and the Scandinavian countries uninhabitable. The *Scientific American*, in commenting upon the scheme, expresses the hope that the gift of imagination will be so mercifully tempered by the saving grace of humor, that the measure will be given an early burial with such obsequies as are becoming to its dignity and importance.

\* \* \*

In tests made by French engineers to determine the most favorable conditions under which belting should be run, it was found that the greatest efficiency of transmission was obtained when oak tanned belts ran at a speed of from 65 to 80 feet per second. What is termed "chromium-treated" leather belts ran most favorably at about 100 feet per second. The most satisfactory working tension was from 575 to 850 pounds per square inch of section. The tests indicated that the thickness of the belt should be from 1/20 to 1/30 of the radius of the pulley. When chromium-treated belts are used, which are more elastic, a thickness of about 1/15 of the radius is permissible. In fact, a chromium-treated leather belt, 0.4 inch thick, gave good results on a pulley 9 3/8 inches in diameter.

\* \* \*

A suspension bridge of much greater extension than any yet erected has been proposed to span the Mersey at Liverpool, England. The main span will be 2700 feet long with towers 500 feet high. The height of the center of the bridge from high water mark will be 200 feet.

## THE ENGINEERING WORKSHOPS OF THE UNIVERSITY OF SHEFFIELD\*

## NOTES ON THE MECHANICAL EQUIPMENT AND METHODS OF INSTRUCTION

BY GEORGE W. BURLEY†

The University of Sheffield is one of several higher educational institutions which have sprung into existence during the past ten or fifteen years in England. These universities aim at giving instruction and offering opportunities for research work in the arts and sciences, but chiefly in technology or

from which year instruction in engineering and mechanical science has been given continuously, engineering-workshop practice also being included in this course. The history of the workshops is practically the history of the whole institution, since the curriculum in engineering includes for each student a certain number of hours per week in actual workshop practice. The ordinary course (whether degree, associateship or non-associateship) in engineering is of three years' duration, and all students in mechanical and electrical engineering during those three years have to work from three to eight hours per week in two shops, the first of which is reserved for first and second year students only, and the second for third year

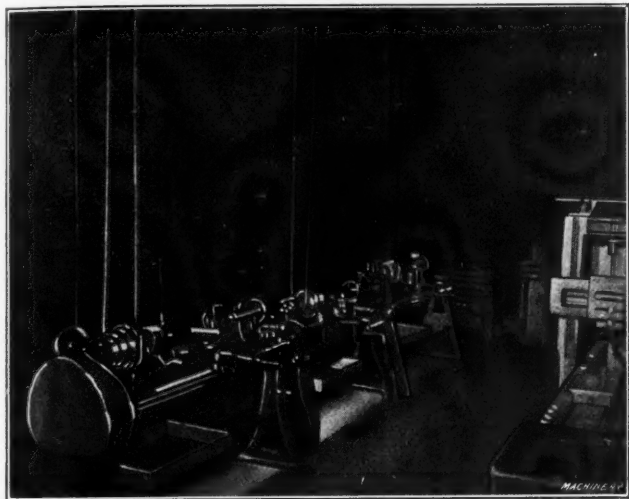


Fig. 1. Machine Shop, First and Second Year Shop

applied science, each university especially developing those applied sciences which are likely to be of benefit to the industries and trades carried on in its own particular district. In the applied science department of Sheffield University, the three chief subjects taught are engineering (mechanical, electrical and civil), metallurgy, and mining, these being the three chief industries of the district in which the university is situated. It is not, however, a purely local institution, and aims to be of service to the engineering and metallurgical industries of the whole country.

This university is the outcome of the development of three local teaching institutions, of which the old Sheffield Technical

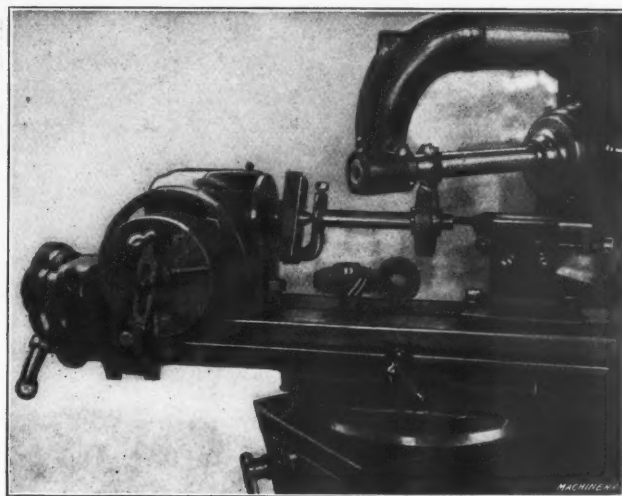


Fig. 3. Milling Spiral Gears

and advanced students. The work in the latter shop is, naturally, of a higher order than that which is done in the other. The number of students who pass through the shops each year varies from 100 to 120.

In the first shop there is an equipment of modern machine tools, including a large number of engine lathes (of English and American manufacture) ranging from eight-inch swing to twenty-two-inch swing, universal and plain horizontal-spindle milling machines, planing machines, sensitive and upright or pillar drilling machines, power hacksaws, cylindrical grinders and wet tool grinders. A general view of this shop is shown in Fig. 1.

In the second shop, which is virtually a large tool-room, the machine tool equipment comprises engine lathes, relieving or backing-off lathe, universal milling machines, universal cutter grinding machines, planing machine, shaping machine, Gisholt universal tool grinder, wet tool grinder, sensitive, upright and high-speed drilling machines, power hacksaw, and turret lathe. In this shop is also situated the experimental high-speed tool steel testing plant, which consists of an electrically-driven thirty-six-inch swing lathe provided with an independent electric motor. A general view of

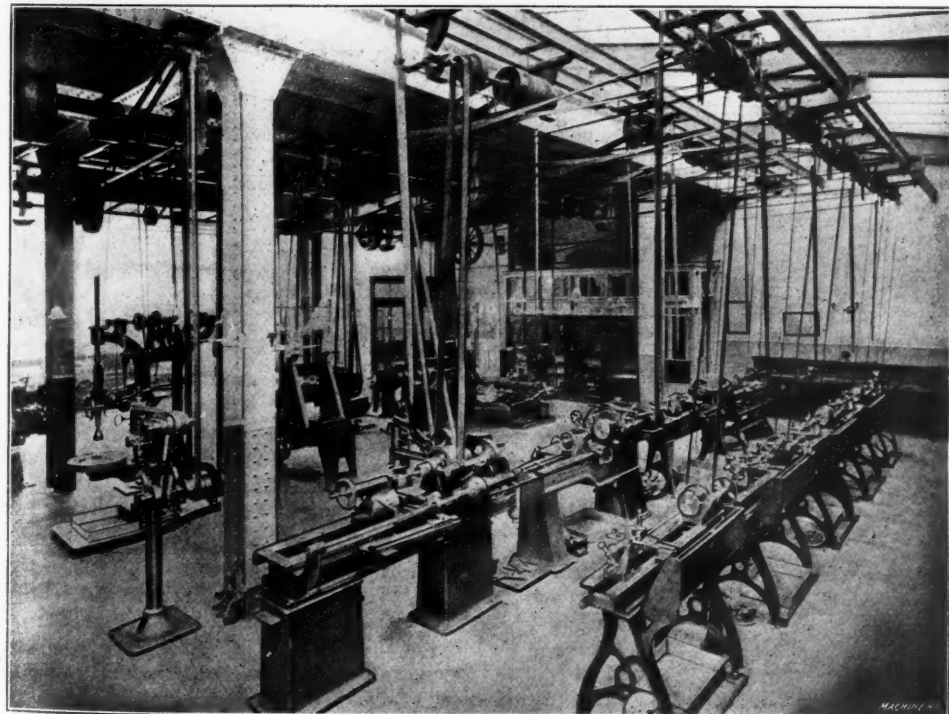


Fig. 2. Tool-room, Third Year Shop

School was one, the latter, on the creation of the university, being converted into the applied science department of the university. The old technical school dates from the year 1886,

this shop is shown in Fig. 2.

In common with the principles which operate in other educational institutions of this type, the prime object of sending students through the shops is not necessarily to convert these students into expert mechanics (for the time which is devoted to work in the shops is not by any means sufficient for this purpose), but to enable the students to get an insight into the

\* For articles on trade schools and engineering shops, see "State Trade School of Bridgeport," October, 1912; "Features of Apprenticeship System at the G. E. Lynn Works," April, 1912; "Training of Machinists in the Trade School," July, 1911, and the articles there referred to.

† Address: University of Sheffield, Sheffield, England.

actual working of machine tools, their possibilities, their weaknesses and their efficiency, and to learn how the various machine tool operations are performed, so that they can compare the different methods of doing the same kind of work. The work which is given to the students is graduated and carefully selected, so that the students who enter the shops in their first year are given the simplest work to do and the simplest machine tool operations to perform, the grade of the work from this being gradually yet surely improved. The whole range of the work enables the students with alert minds to grasp readily the principles which underlie the working of every machine tool in the shops, while in addition to this

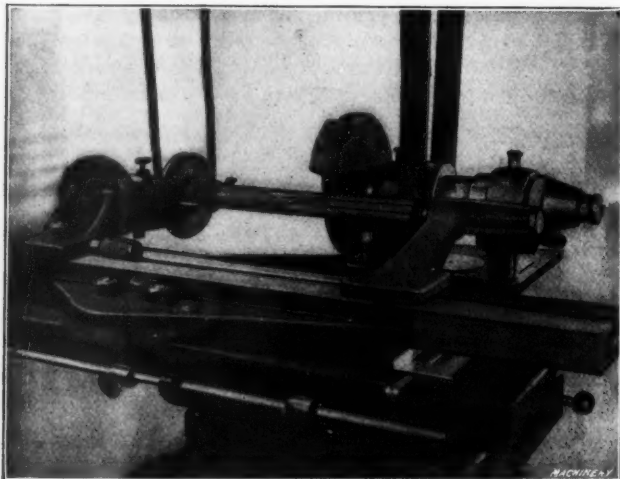


Fig. 4. Grinding Hand Reamers

practical acquaintance with machine tools, weekly lectures on the theory and practice of machine tools are given to assist the students in their work and to add to their store of knowledge in connection with machine tools and their operation in their latest phases.

The work in the first and second year shop begins with hand bench operations, such as chipping and filing up square blocks, making simple surface gages or scribing blocks, angle gages and similar tools. This is followed by machine tool work, plain turning, taper turning, surfacing, boring and screw-cutting operations on the lathe, being performed in a progressive manner. The drilling machine, planing machine, shaping machine and slotting machine are all, in turn, worked

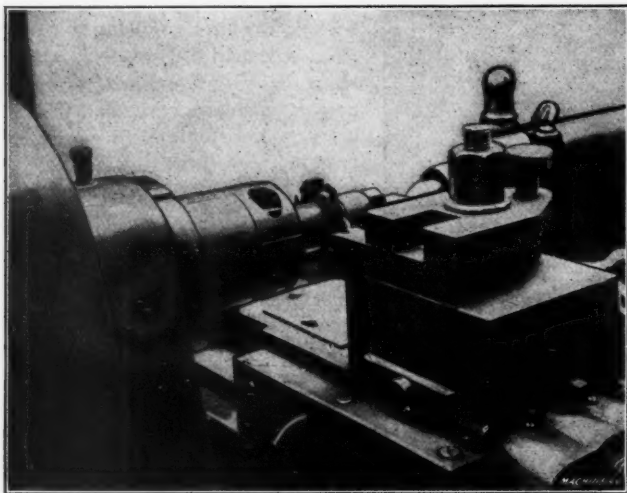


Fig. 5. Backing off Formed Milling Cutters

on by every student. Second year students who make exceptionally good progress, are put on to the making of simple steam, gas and petrol engines, all the operations connected with this kind of work being done by the students themselves under the tuition of expert instructors.

The work which is done in the third year shop is of a tool-room character. It includes the making of limit gages, standard ring and plug gages, stepped gages, fluted and formed milling cutters, reamers, twist drills and similar tools, the cutting of spur, spiral, bevel and worm gears, and the making of jigs, templets, laps, etc. All the operations are of the precision type, and the students are taught the use of the pre-

cision tools such as the micrometer gages, outside and inside, the limit gage, the thread gage, the standard gage (internal and external), the test indicator, and the gear-tooth depth gage. Furthermore, all the machine tools have their feed-screws and elevating and horizontal adjusting screws provided with micrometrically graduated dials, and these the students are taught to use. Comparisons between different methods of doing the same kind of work or effecting the same object are made, as well as tests of the accuracy of machine tools and work turned out on them. The principle of this shop is the combination of accuracy or exactitude with economy of production as far as such a combination can be effected.

In Fig. 3 is represented the cutting of spiral gears on a universal milling machine, this being an exercise that is done by every student. In Fig. 4 is shown the grinding of a hand reamer after hardening. This operation is performed on a Cincinnati universal cutter grinder, the precise operation represented being the circular grinding of the whole reamer prior to grinding the clearance or relief on the teeth.

A feature of this tool-room is that it can accommodate practically every machine tool required for tool-room opera-

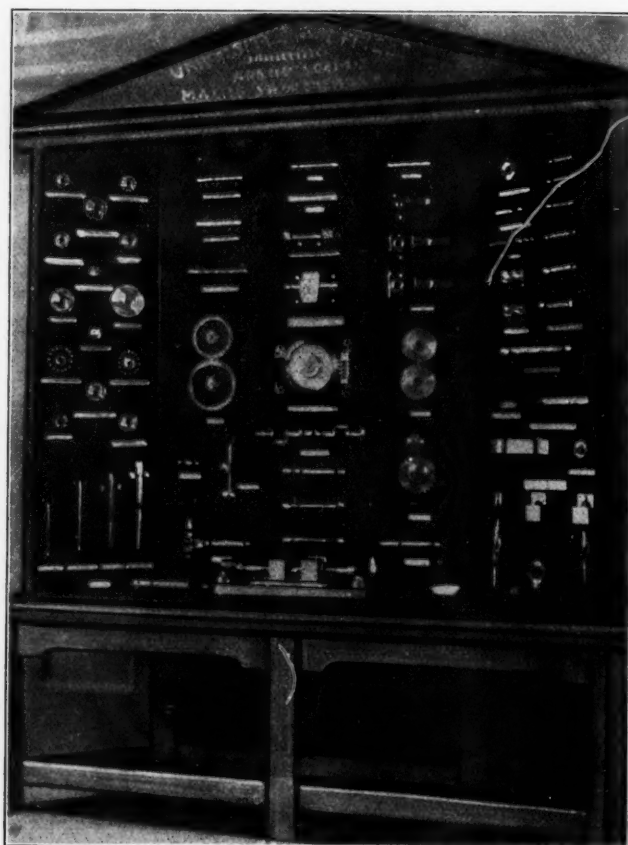


Fig. 6. Exhibition Case of Students' Work

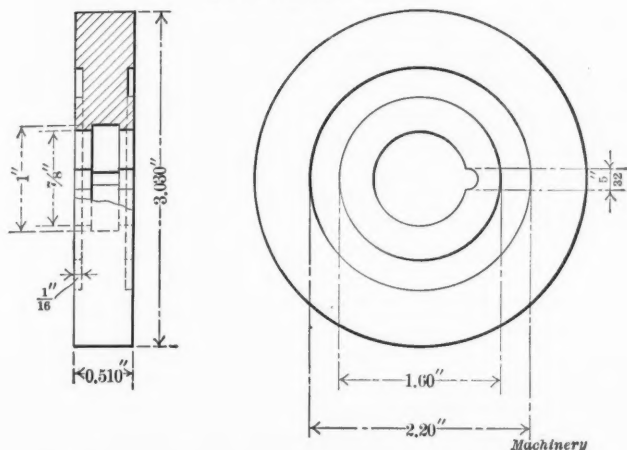
tions, usual and unusual. One machine tool, not found in every tool-room, is the backing-off or relieving lathe. An example is, however, installed in this shop, this being a Loewe machine. On this machine are formed and backed-off twist drill fluting cutters, reamer fluting cutters, work hobs and gear-cutters, all of these being made from first principles, as it were, including the initial laying out of the shape, the making of templets and the forming of the forming tools. In Fig. 5 is shown the last operation before hardening and grinding, viz, the relieving or backing-off of a cutter such as any of the above, in the Loewe lathe. This lathe has a differential mechanism for use in connection with the forming and relieving of worm hobs to get the exact number of reciprocations of the forming tool per revolution of the hob, and the students are taught how to use this and how to perform the calculations required to obtain the setting of the mechanism.

A view of a case of students' work (chiefly tool-room work), which was exhibited at the Franco-British Exhibition in London, England, in 1908, is shown in Fig. 6.

A sample operation or exercise sheet with accompanying drawings is shown herewith, the students being given the material required, its dimensions, and the sequence of the operations to be performed on the material, together with instructions as to how best to set about the work:

## EXERCISE NO. 12

## SLOTTING CUTTER



Make a  $\frac{1}{2}$ -inch slotting cutter (for milling keyways in shafts, etc.). Material:  $3\frac{1}{8}$ -inch diameter cutter blank,  $\frac{5}{8}$ -inch thick. Annealed cast steel. Method: (1) Fix the blank in the lathe chuck and face the side. Rechuck, and face the other side to  $\frac{1}{32}$  inch above size. Drill a  $\frac{55}{64}$ -inch hole in the blank, and bore out to  $\frac{7}{8}$  inch, using the limit gage to get this dimension. (2) Place the blank on a mandrel, turn to the required size, then turn and recess faces as shown in drawing. (3) Remove the blank from mandrel, drive a  $\frac{7}{8}$ -inch turned plug in hole till it is level on each side, then drill keyway out to required size. (4) Replace the blank on the mandrel, mount it between the centers of the heads of the universal milling machines, and set the indexing head for 26 divisions. (5) Place a

cutter from the mandrel, and stamp its dimensions on before it is hardened. (15) Heat in salt bath to a temperature of from 790 to 800 degrees C. and plunge it into the quenching bath in a vertical position, afterward moving it about horizontally to and fro beneath the surface until it is the same temperature as the bath, that is, about 25 degrees C. (16) Temper the cutter down, using a temperature of about 230 degrees C. (17) Fix up a universal grinding machine: first, to grind out the hole to standard size, using the limit gage to test the size; second, to grind five degrees clearance on the axial teeth, treating each tooth separately; third, to grind five degrees clearance of the radial teeth on one side; and fourth, to treat the other side in the same manner, making the width of the cutter 0.500 inch and the two sides alike.

In Fig. 7 is shown a high-speed steel testing lathe which has been installed in the tool-room. It is a thirty-six-inch swing lathe and will take test bars up to ten feet in length. It is provided with two electric motors, one being the driving motor of forty horsepower and the other a feed motor of five horsepower. The latter is so arranged that it can be either connected or disconnected to the feed-rod. In the latter case, the power feed of the slide-rest is obtained direct from the main driving spindle of the headstock of the lathe. The headstock of the lathe is designed so that the driving spindle can be connected direct or through gearing to the armature shaft of the driving motor. There are three sets of gearing of different ratios from four to one to forty to one; hence, with two field-circuit rheostats for the motor in series and 253 different rheostat contact combinations available, upward of 1000 different spindle and test bar speeds are possible for one voltage. Any feed of the slide-rest up to 200 inches per minute is also available, so that the ranges of speed and feed in this lathe are fairly extensive. The tailstock is designed so that whenever necessary, drilling tests can be made on the

lathe, it being possible to obtain a spindle speed of 800 revolutions per minute.

On this lathe, many tests of lathe cutting tools of both the plain carbon and high-speed varieties have been made by the present writer; and particular mention should be made of the "speed-increment" or "increasing speed" test for high-speed lathe cutting tools which was originated on this lathe. In this test the cutting speed is not maintained constant, but is started at thirty feet per minute and then increased by an increment of one foot per minute every minute of the test until the point of breakdown of the tool is reached. The criterion value of the tool is the number of cubic inches of metal that it will remove from the test bar under such conditions, the depth of the cut and the feed per revolution being, of course, kept constant in any series of comparative tests. The small increments of speed which are required are obtainable quite easily by means of the two rheostats with which the

lathe is provided. To obtain the same results with a single rheostat would involve an unusually large number of contacts, whereas in this case only forty-four contacts are used.

\* \* \*

The report of the Association of German Machine Tool Builders for the last year states that the exports of machine tools from Germany continue to increase, the total being 77,000 tons against 64,500 tons in 1911. The number of men employed in the manufacture of machine tools in Germany is stated to be about 80,000, in addition to which there are over 7000 foremen, superintendents, managers, etc. The value of the total output of the machine tool industry in Germany is estimated to be \$55,000,000. The heaviest exports of machine tools from Germany are to Austria-Hungary, Russia and France, which three countries take nearly one-half of the total exports.

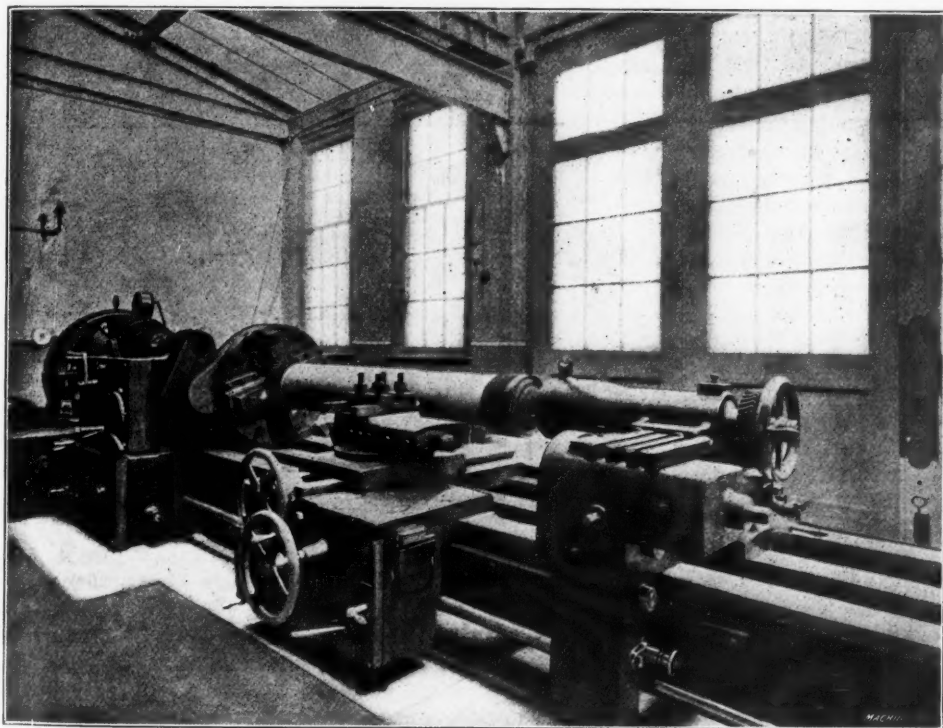


Fig. 7. High-speed Experimental Lathe

65-degree single-angle fluting cutter on the milling machine spindle, and adjust the position of the blank until the cutter is set central with respect to the blank. (6) Adjust the micrometer dial on the elevating screw handle to zero and then with the cutter not immediately above the blank, raise the knee 0.1300 inch for the first cut; the 26 teeth can now be rough-cut. (7) Raise the knee another 0.0115 inch, and then run around the blank with a finishing cut. (This depth of cut is based upon a land-width ratio of 0.020.) (8) Remove the blank from the mandrel and mount it on the tapered mandrel which fits in the spindle of the dividing head. (9) Set the dividing-head spindle at an angle of 86 degrees 13 minutes with the horizontal. (10) Remove the 65-degree cutter and substitute a 75-degree cutter for it. (11) Obtain the position of initial setting for a right-hand cutter, raise the blank 0.0850 inch and rough-cut one side of the blank. (12) Raise the blank another 0.0109 inch and finish-cut the teeth on that side. (These dimensions are based upon a land-width ratio of 0.020 as above). (13) Substitute a 75-degree fluting cutter of the left-hand type for the above and repeat the operations. (14) Remove the

## STEAM POWER PLANT PIPING DETAILS—4

## DANGERS OF WATER SLUGS—DRIP CONNECTIONS—CONDENSATION LOSSES—SEPARATORS

BY WILLIAM F. FISCHER\*

In previous articles the writer has, in a general way, called attention to the necessity of keeping live steam mains drained free from water in order to prevent accidents resulting from water-hammer. In the present article the subject will be treated at more length, in order that the designer may have a better idea of the methods employed in caring for condensation and preventing dangerous water pockets. Probably the greatest source of danger to engines of the reciprocating type is the liability of water collecting in the steam piping system, which, unless properly drained off or stopped by a steam separator, eventually finds its way to the engine cylinders in "doses" or "slugs." This is particularly dangerous in high-speed engines, owing to the small clearance space at each end of the cylinder. Water has a great capacity for absorbing heat, and when allowed to accumulate in the steam mains, it has a tendency to condense part of the steam flowing through them. Any steam thus condensed, though small in amount, must be replaced by the boiler, and the cost of generating extra steam for this purpose will amount to a considerable sum of money during the course of a year. Initial condensation occurring in a steam engine cylinder is a good example of this loss. Water lying in the cylinder, or swept in by the steam flow, chills the cylinder walls which, in turn, tend to cool down and condense part of the hot steam entering the cylinder at the next stroke of the piston. Consequently, a greater quantity of steam must be admitted to the cylinder than would otherwise be required to do the work. Initial condensation also causes a corresponding drop in pressure and causes disagreeable and dangerous pounding or knocking in the engine cylinder as the water is driven back and forth by the piston.

## Condensation Losses

The presence of water in steam mains is due to the condensation of steam in the pipes, and, in some cases, to priming or foaming of the boilers where water is at times carried over by the steam leaving the boiler at high velocity. Heated surfaces naturally lose heat when brought into contact with a cooler surface or element. Thus between two bodies which are near each other, or in contact with each other, there exists a tendency toward temperature equalization, by radiation, conduction and convection. A pipe carrying steam at a temperature of from 212 degrees F. and upward, which is in contact with the surrounding atmosphere—the temperature of which seldom exceeds 100 degrees F.—is quite naturally the cause of a rapid radiation of heat from the surface of the pipe to the surrounding atmosphere. This rapid radiation of heat is what causes condensation of the steam in the pipes; it is also responsible for a direct loss of the heat which is derived from the fuel and stored up in the steam, and for this reason radiation should be prevented as far as possible by covering all live steam mains with a good grade of non-conducting pipe covering of some standard make. Experiments by different authorities show that a bare steam pipe surrounded by air, will radiate about three B. T. U. per square foot of pipe surface per hour, for each degree F. difference between the temperature of the steam in the pipe and the temperature of the surrounding air. Tests made by Mr. George H. Brill on an 8-inch standard steam pipe 60 feet long, carrying steam at from 109 to 117 pounds per square inch, gage pressure, and surrounded by air at temperatures varying from 58 to 81 degrees F. show that each square foot of bare pipe surface radiates approximately 2.706 B. T. U. per hour, per degree average difference of temperature between the steam in the pipe and the outside air. This agrees very closely with tests made by Mr. H. G. Stott, who found the loss in bare pipes to be 2.708 B. T. U. per square foot, per hour, per degree difference in temperature between the steam and air. (For results of the tests mentioned see "Kent's Mechanical Engineers Pocket Book," eighth edition, pages 559 to 561 inclusive.)

The actual heat losses in a steam pipe will, of course, depend upon the size of the pipe, its position, the nature of the pipe

surface and the velocity of the air surrounding the pipe. Horizontal steam pipes radiate heat more rapidly than vertical pipes, the reason for this being that the heated air surrounding a vertical pipe travels upward along the surface of the pipe, while with horizontal pipes the heated air rises immediately upon being heated, thus making room for cooler air which is, in turn, heated. For all practical purposes, however, it is customary to assume a loss of three B. T. U. per square foot, per hour for each degree F. difference in temperature between the steam in the pipe and the air surrounding the pipe, as previously mentioned. The following examples will serve to illustrate the loss due to radiation in an uncovered steam pipe, and the saving which may be effected by covering the pipe with a good grade of non-conducting pipe covering.

*Example 1.*—A standard 10-inch uncovered steam pipe, 200 feet long, carrying saturated steam at 150 pounds gage pressure (165 pounds absolute) is surrounded by air at an average temperature of 60 degrees F. How many B. T. U. (heat units) will be given off per hour, and how many pounds of steam will condense in the pipe in one hour?

*Answer.*—The actual outside circumference of a 10-inch standard steel or wrought-iron pipe is 33.77 inches or  $33.77 \div 12 = 2.8$  feet, approximately. The circumference of standard steam pipes may be found in the manufacturers' catalogues. The circumference of the pipe, in feet, multiplied by the length in feet will give the exposed surface of the pipe in square feet. Therefore:  $2.8 \times 200 = 560$  square feet of outside or exposed surface in this case. The temperature of steam at 150 pounds gage pressure (165 pounds absolute pressure) is 366 degrees F., and the temperature of the air, as previously given, is 60 degrees F. Therefore, the difference in temperature between the steam and air is  $366 - 60 = 306$  degrees F. Assuming a loss of three heat units per hour, per degree difference in temperature, for each square foot of exposed pipe surface, we have:  $3 \times 560 \times 306 = 514,080$  heat units radiated or given off from the 10-inch pipe in one hour.

Putting the above calculation in the form of an algebraic equation, we get:

$$R = 3 S (T - t) \quad (1)$$

where

$R$  = the number of B. T. U. given off from the surface of a bare steam pipe in one hour;

$S$  = exposed surface of pipe in square feet;

$T$  = temperature of steam in pipe, in degrees F. (Found in steam tables.)

$t$  = temperature of the air surrounding the pipe, in degrees F.

Applying Equation (1) in the preceding example, we get:  $R = 3 S (T - t) = 3 \times 560 \times (366 - 60) = 514,080$  B. T. U. per hour.

If superheated steam is used in the piping system, the temperature  $T$  of the steam will be higher than for saturated steam, and this should be taken into account when applying the formula for superheated steam.

To find the weight of steam condensed in the pipe in one hour, proceed as follows: From the steam tables we find the latent heat of evaporation for saturated steam at 150 pounds gage pressure (165 pounds absolute) to be 856.8 B. T. U. per pound. This means that 856.8 B. T. U. must be added to each pound of water in the boiler to change it into steam at a temperature of 366 degrees F. and a pressure of 150 pounds (gage) without increasing its temperature during the process of evaporation. In other words, after the water has been evaporated or turned into steam, each pound of steam has absorbed 856.8 B. T. U. during the process of evaporation, but the temperature of the steam still remains the same as the temperature of the water from which it was formed. In the reverse order, if we extract 856.8 B. T. U. from a pound of steam at 150 pounds gage pressure (165 pounds absolute) it will condense or be changed again into the form of water, the water of condensation having the same temperature as the steam from which it was condensed. It follows, therefore,

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that for every 856.8 B. T. U. that is radiated or given off from the surface of the 10-inch steam pipe in the preceding example, one pound of steam will be condensed. Since 514,080 B. T. U. are given off in one hour, we have  $514,080 \div 856.8 = 600$  pounds of steam condensed per hour, and, consequently, 600 pounds of water per hour to be drained from the pipe and returned to the boilers or the feed water heater, as the case may be. Putting the preceding discussion in the form of an algebraic equation, we have:

$$C = \frac{R}{V} = \frac{3 S (T - t)}{V} \quad (2)$$

where  $R$ ,  $S$ ,  $T$  and  $t$  are the same as given in Equation (1).

$C$  = weight of steam condensed in bare steam pipe, in pounds per hour.

$V$  = latent heat of evaporation at the given steam pressure and temperature, as given in the steam tables.

Applying Equation (2) in the preceding example, we get:

$$C = \frac{3 S (T - t)}{V} = \frac{3 \times 560 \times (366 - 60)}{856.8} = 600$$

pounds of steam condensed per hour.

Adding 15 pounds to the pressure as recorded on a steam gage gives absolute pressure near enough for all practical purposes. Thus 150 pounds gage pressure =  $150 + 15 = 165$  pounds absolute pressure.

#### Saving due to Covering Steam Pipes

In the preceding examples we have determined the heat losses from a bare pipe and the weight of steam condensed as a result of this heat loss. The following examples will show the saving in heat units, condensation and cost of coal by covering the pipe with a good grade of steam pipe covering material. When coal or any other fuel is burned under a boiler, part of the heat passes off in the gases escaping up the stack and is lost in creating draft. With a good grade of steam coal averaging about 14,000 B. T. U. per pound, about 10,000 B. T. U. may be utilized in making steam in a well-designed boiler that is properly fired, the balance of the heat passing off to the atmosphere.

*Example 2.*—Assuming that 10,000 B. T. U. are utilized from each pound of coal burned in making steam, how many pounds

hours per day, the loss would amount to about \$1.00 or nearly \$2.00 per twenty-four-hour day.

A good grade of asbestos or similar pipe covering will reduce this loss at least 85 per cent, in which case only 77,112 B. T. U. will be given off from the covered pipe per hour, and only 90 pounds of steam will be condensed per hour. The cost of fuel per hour that is required to make good the loss in the covered pipe will be approximately one cent, which represents a saving of seven cents per hour. A 10-inch steam pipe 200 feet long may be covered with a good grade of pipe covering for about \$125, including materials and labor, the exact cost depending upon the location of the plant. Therefore, at a saving of seven cents per hour, the covering will pay for itself in about 1800 hours of operation. Knowing the exact

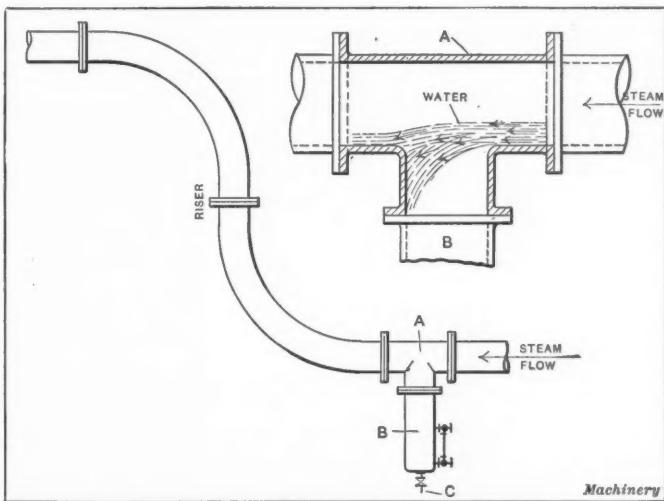
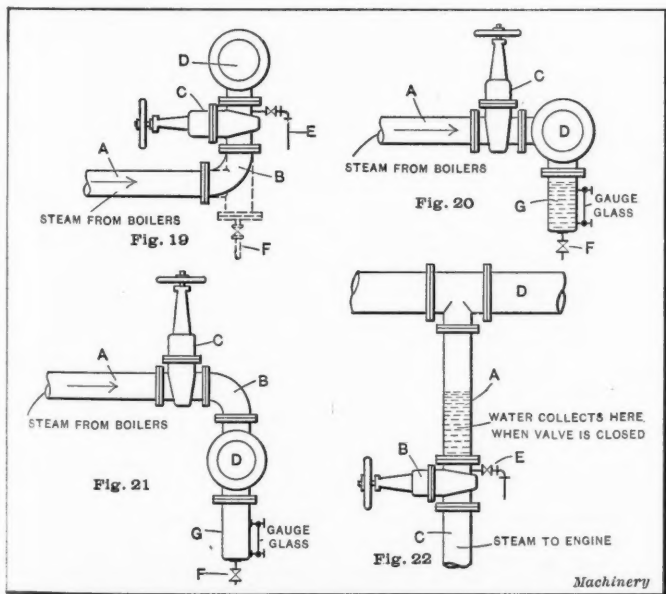


Fig. 23. Riser taken off at End of Header and Method of draining Riser

conditions in any plant, the condensation losses may be estimated in a similar manner, and after prices are obtained on pipe covering it is a simple matter to estimate the saving made possible by covering the pipes. Outdoor steam pipes should be well protected and heavily insulated, as they are exposed to all kinds of weather, and cold winds sweeping across them at high velocity will cause very rapid condensation of the steam. The saving due to covering outdoor pipes will be considerably greater than for indoor pipe work, but this additional saving is greatly offset by the extra wear and tear on the pipe covering exposed to the elements. Where it is practical to do so, outdoor steam pipes are usually run in pipe tunnels or trenches beneath the ground level and well insulated. As it would require considerable space to describe the different non-conducting pipe coverings now on the market, the writer feels that he can do no better than refer the reader to the manufacturers' catalogues and data, which any pipe covering manufacturer will gladly furnish upon request.

#### Superheated Steam

In modern steam power plants, the condensation losses may be reduced to a minimum by the use of superheated steam and the proper pipe covering. In any steam power plant, however, there are certain prime movers which are apt to be shut down over certain periods, especially when the station load is light. In such cases there will be no steam flow in that branch of the piping system which supplies the idle units. If the pipe lines are kept alive under these conditions, the steam will condense and deposit water in the low spots or "pockets" of the system if there are any. When a branch pipe is shut down or cut out of service over certain periods, the live steam remaining in the pipes will gradually condense and the pipes cool down considerably, in which case there is always more or less danger of water forming in them when they are again opened to the steam flow. This is caused by the hot steam coming into contact with the cool surfaces of the pipe and fittings, and thus condensation occurs very rapidly until such a time as the branch pipe is again warmed to approximately the temperature of the steam flowing through it. Condensation occurs less rapidly in pipes carrying superheated steam than in those carrying saturated steam. Before any water of condensation can form with superheated steam in the pipes, the surplus



Figs. 19-22. Methods of draining Water of Condensation from Main Header

of coal must be burned to supply the heat lost from 200 feet of 10-inch pipe in Example 1?

*Answer.*—Since 514,080 heat units are given off per hour,  $514,080 \div 10,000 = 51.4$  pounds of coal per hour which must be burned to make good the heat lost from the bare pipe. One ton = 2000 pounds; therefore, at say \$3.00 per ton, 51.4 pounds

of coal would cost  $\frac{51.4 \times 3.00}{2000} = 0.08$  or 8 cents, approxi-

mately. In other words, the heat lost from the pipe in one hour would have a money value of 8 cents. Operating twelve

heat units or superheat must first be extracted from the steam, or in other words, the superheated steam must first be reduced to saturated steam at the same pressure, or less, before condensation occurs. Superheated steam is produced by adding heat to saturated steam after it has been removed from contact with the water from which it was formed. This is accomplished by passing the steam through superheater coils after it leaves the boiler drums, the superheater coils being located in the path of the hot gases from the boiler furnace from which the coils absorb a portion of the waste heat as it passes off to the stack.

The thermal conductivity of superheated steam is much lower than that of saturated steam; hence the heat will not be so rapidly transmitted to the walls of the pipe. By adding sufficient superheat before the steam leaves the boilers, it is

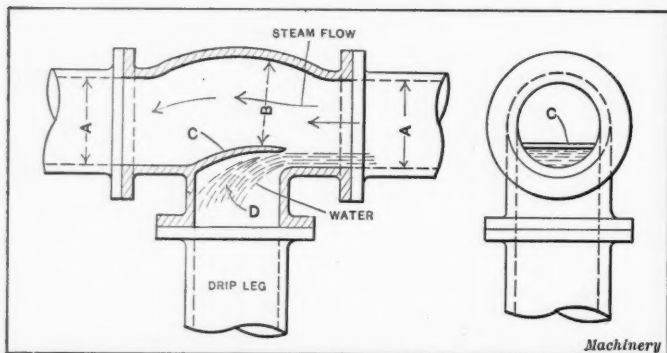


Fig. 24. Special Fitting for diverting Flow of Water into Drip Leg

possible to deliver it to the engines or turbines in a perfectly dry condition. This means that sufficient heat must be added to the steam to make good the heat radiated from the piping system and the heat lost in warming the cylinder walls of the engine at each stroke of the piston. It has been found in practice, however, that even in power plants where highly superheated steam is employed, a certain amount of condensation occurs in the piping system and that water is at times carried over from the boilers during peak loads, this water passing through the superheater and into the steam mains without being evaporated. It is therefore absolutely necessary for the proper precautions to be taken, when designing the piping system, to see that water pockets and low spots in which water can collect are avoided as far as possible, or that they are drained in a manner that will prevent accidents resulting from water-hammer.

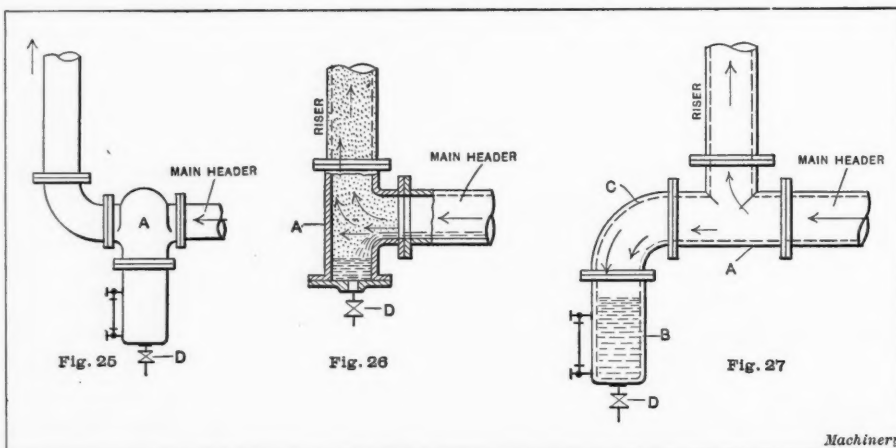
Steam pipes are usually proportioned so that the steam flowing in them travels at a rate of from 6000 to 10,000 feet per minute, and in some cases much faster; hence if a "slug" of water is picked up by the steam and projected against a fitting or blind flange, an accident is likely to result from the rupture of some part of the piping system, or the water may be swept into the engine cylinder and cause an accident to the engine. Even though the quantity of water in the steam mains may not be sufficient to cause serious damage to the system, it may be responsible for disagreeable knocking and hammering in the pipes and engine cylinder which, in turn, causes vibration that may finally cause the joints to leak. The knocking or hammering, so common in steam heating plants where steam is turned into a cold pipe or radiator, is what is known as "water-hammer." The shock or pressure produced by water-hammer in steam mains is many times that which the piping, valves and fittings are ordinarily designed for or expected to sustain. This fact is borne out in practice by the large number of accidents that may be traced to this cause alone. To avoid water-hammer and the other evils which result from condensation in the mains, water pockets in the steam piping system should be avoided as far as possible, or else they should be drained free from water as fast as it collects.

#### Avoiding Water Pockets in Steam Mains

Fig. 19 shows a very poor method of connecting the boiler leads to the main steam header. With the piping arranged in this manner, the valve C, when closed, forms a water pocket in the line above the valve seat. With the valve open, the water of condensation forming in the main steam header D tends to flow back to the boilers against the steam flow. This condition should be avoided, wherever it is possible to do so, for if it is attempted to run the water of condensation against the steam flow, water-hammer is likely to occur by the flowing steam holding the water back and driving it over to the header again in large "doses" or "slugs," unless the pipe leading from the boiler is exceptionally large and the velocity of the flowing steam much below the average, as in steam heating plants, etc. If it becomes absolutely necessary to arrange the piping as shown in Fig. 19, the valve C should be dripped above the seat as shown at E. It might also be advisable to substitute a tee fitting for the elbow B, as shown by the dotted lines, and drip the blind flange at the end of the tee at F, thus providing a drip leg or well at the low point of the system. Fig. 20 shows a better arrangement of the piping, in which case the steam enters the main header on the side, a drip pocket being provided on the header as shown at G.

Fig. 21 shows a far better method of arranging the piping. In this case the steam enters at the top of the header, leaving no low spots or pockets except in the header itself. The drip leg G, if properly drained, will keep the main header dry during operation. When steam is taken from the bottom of the main header, as shown in Fig. 22, the stop valve is quite frequently placed some distance below the header as shown at B, in order to be within reach of the operator. In this case water will drain from the header D into the pipe A and collect there when the valve is closed. For this reason valve B should be dripped above the seat as shown at E. Wherever possible, steam should be taken from the top of the header as in Fig. 21.

In some cases it may be found necessary to offset the main header, or take off a riser (vertical pipe) at the extreme end of the header, as shown in Figs. 23, 25, 26 and 27. In these cases, the header forms a water pocket at the base of the riser where water may collect in sufficient quantities to gradually decrease the effective area of the pipe, in which case the first heavy flow of steam is apt to pick up a large "slug" of water, sweep it up through the vertical riser and project it with great force against the nearest fitting or blind flange,



Figs. 25-27. Methods of draining Riser Pipes

with the danger of causing serious damage to the piping system. In cases of this kind it is always advisable to provide a drip connection at or near the base of the riser, so that the water of condensation may be drained off at this point. Fig. 23 shows the header dripped through a common tee fitting A, drip leg B and drain C. In the enlarged section of the tee, the action of the steam and water in flowing across the opening or outlet of the tee is shown. When the steam is flowing at low velocity, the water passing along the bottom of the header will fall freely through the outlet of the tee into the drip leg B. If the steam is traveling at high velocity, however, as is usually the case in high-pressure piping systems, the steam will sweep most of the water across the opening, as shown in the illustration, and carry it up through the riser.

In Fig. 24 is shown a special tee fitting which may be used in cases of this kind to prevent the water being swept past the opening in the tee. A partition *C* is cast on the fitting which intercepts the water flowing along the bottom of the pipe and deflects it into the well or drip leg, as shown at *D*, the steam traveling over the partition as shown by the arrows. When designing special fittings of this type, care should be taken to see that sufficient area is provided at any point *B*, so that the steam flow is not restricted. The writer would suggest making the area at *B* from 10 to 25 per cent greater than the effective area of the pipe, and in no case less than the area of the pipe. This fitting is effective only when the steam flow is in the direction of the arrows. In place of the special fitting just described, a separator is sometimes used at this point in the piping system, as shown at *A* Fig. 25. Fig. 26 shows another method of draining the main header at the base of the riser. With this arrangement the water of condensation is swept along at high velocity by the steam flow, and upon striking against the back of the tee *A*, as shown by the arrows, it is suddenly arrested and broken up into fine particles or drops, some of which are caught up again by the flowing steam and carried up through the riser as shown by the dots in the illustration. Fig. 27 shows an improvement on the piping arrangement just described. The tee fitting *A* is placed horizontally in the line, with the riser connected to the outlet and the drip leg *B* connected to the extreme end of the line through the elbow *C*. With this arrangement the water of condensation is swept along to the end of the line, without meeting any obstruction, and falls through the elbow into the drip leg *B*, where it is drained off through drip pipe *D*.

When installing an expansion loop or bend in a steam line, lack of space sometimes makes it impossible to place the bend horizontally as it should be, in which case it may be turned up in a vertical position and the header drained at each side of the bend, as shown in Fig. 28. In this particular case, the installation of a ventilating flue *A* made it necessary to change the main steam piping and carry it above the flue at this point. This was accomplished by removing a straight section of the header, as shown by the dotted lines *B* and substituting tees *C* and bends *D*, *E* and *F*. If the pipe bends were turned down

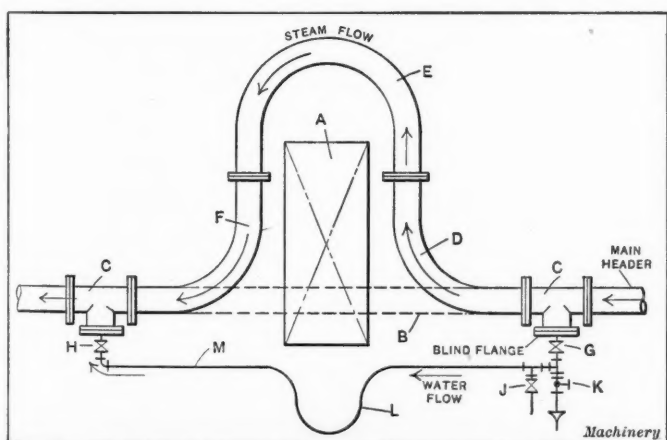


Fig. 28. Method of carrying Expansion Bend over an Obstruction and draining Header

instead of up, bend *E* would form a dangerous water pocket in the line. As it is, water pockets are formed at each side of the bend, at the point *C*, but these are drained free from water in the following manner. Each of the tees *C* is fitted with a blind flange drilled and tapped for a drip connection; and the drip pipe *M* makes connection between these two points through the drip valves *G* and *H*. These drip valves are provided for emergency use only, in case of accident to the drip piping, and should always remain open during operation. The drip main *M* should be connected to a steam trap or other drip return system, through valve *J*. In addition to this drain connection, it is well to provide an open bleeder, or emergency "test drain" connection, as shown at *K*. This connection leads to an open funnel-shaped fitting, and will be found useful in draining the piping system before turning on steam over night, or in testing the system to see that the piping is being properly drained during operation. A bend should be provided in the drip main, as shown at *L*, in order to relieve the expansion

and contraction strains in this section of the piping and prevent leakage at the pipe joints.

The operation of this system is as follows: With valves *G* and *H* open, the steam flowing in the direction of the arrows will travel through the bends *D*, *E* and *F*, as indicated, while the water of condensation flowing along the bottom of the pipe will travel through drip main *M* underneath the flue, as indicated by the arrows marked water flow, and join the steam flow again at the second tee *C*, if drip valves *J* and *K* be closed at the time. If either drip valve *J* or *K* is open, the water will, of course, be drained off at this point during operation. In this way, the water of condensation may be carried on past

an obstruction with the steam flow without danger of waterhammer, whereas if the drip main were not provided, or if the drip valves *G* and *H* were to be closed during operation, water would gradually collect at the first tee *C* and decrease the effective area of the steam main. In this case the first heavy draft of steam would pick up large "slugs" of water and carry them through the bends serious damage to

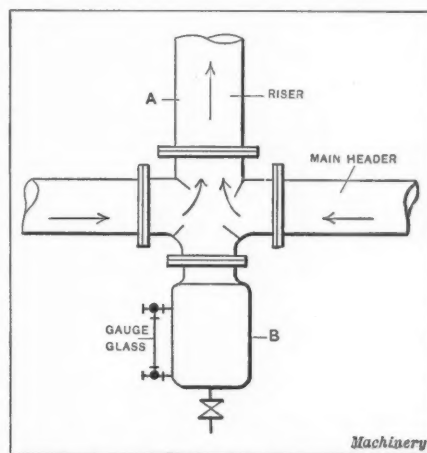


Fig. 29. Method of draining Header at Base of Riser

through the bends into the piping beyond, probably causing serious damage to the system.

Fig. 29 shows a method of draining the main steam header at the base of a riser at *A*. In this case, the steam flow is in the direction of the arrows, tending to sweep the water of condensation from both ends of the header toward the riser. When the draft of steam is heavy and the flow very rapid, as is usual in high-pressure steam mains, it is advisable to install a drip pocket *B* at the base of the riser to take care of the water and prevent it collecting at this point and being carried up through the riser by the steam flow.

Figs. 30, 32, 34, and 36 show several ways in which water pockets are formed in a steam main by the use of concentric reducing fittings. Figs. 31, 33, 35 and 37 show how these water pockets may be avoided by using special eccentric reducing fittings. Wherever a water pocket is formed it should be drained as indicated. The concentric fittings shown in Figs. 30, 32, 34 and 36 are manufacturers' standard fittings, whereas the eccentric fittings shown in Figs. 31, 33, 35 and 37 are "specials," which may be obtained at a slightly increased cost.

## Steam Separators

Steam separators are used in connection with steam power plant pipe work for the purpose of intercepting the moisture in the steam and the water of condensation that flows along with it, before it reaches the engine cylinders or turbines, thus protecting them from damage by water. It is a well known fact that steam engines and turbines operate more economically and at higher efficiency when supplied with dry steam than when supplied with moisture-laden steam of poorer quality. For this reason, a steam separator will effect a saving in fuel which will be sufficient to pay for itself in a few years' time, and at the same time insure a fair return on the money invested. Besides the saving in fuel, a steam separator effects a considerable saving in oil and engine repairs. Where moist steam enters a steam engine cylinder, the moisture is deposited upon the metallic rubbing surfaces of the pistons and on the cylinder walls, thus washing away the oil intended for purposes of lubrication and carrying it out through the drain pipes or exhaust ports. The cutting action of wet steam upon metallic surfaces is generally recognized. In the case of a reciprocating steam engine it has a tendency to cut and score the cylinder walls, pistons, valves and valve seats very rapidly; and in a steam turbine, the water impinging on the blades at high velocity will wear them out in a comparatively short space of time, making frequent renewals necessary.

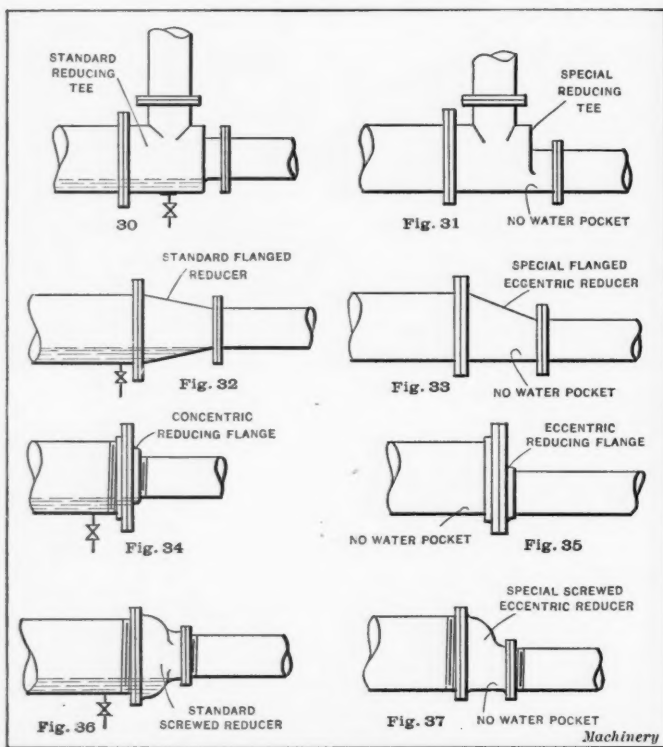
Besides intercepting the moisture in the steam, a separator performs another function of great value in providing a reservoir near the engine cylinder where a large volume of steam is stored when the steam valves close at each stroke of the engine piston. This insures a more uniform pressure in the engine cylinder up to the point of cut-off, and also provides a cushion of steam near the cylinder which absorbs the shock caused by the quick cut-off in the steam chest, thus preventing any vibration being transmitted to the piping system. Steam separators also aid in securing a steady and continuous flow of steam in the direction of the engine, without making it necessary to stop and start the flow with every movement of the engine valve. This steady flow of steam toward the engines reduces the pressure-drop between the boilers and engines, at the same time reducing the tendency of

a globe valve that refuses to close, and finds a loose bolt or nut, a wrench, or an old shoe wedged tightly beneath the seat. Such "junk" left in the piping system during erection eventually finds its way into the engine cylinder, unless stopped by a steam separator, strainer, or similar device. A small nut carried over by the steam flowing to the engines would, unless stopped, lodge in the engine cylinder scoring and cutting it so badly that in a very short time it would be necessary to dismantle the engine and re-bore the cylinder. A small nut, if carried to the nozzle of a steam turbine, would rip the blades from the turbine rotor before the machine could be shut down. Owing to the small clearance space between the blades and casing of a steam turbine, the supply pipe is usually supplied with a strainer to prevent small iron chips, etc., from getting into it. As a general rule the turbine manufacturer supplies this strainer with each machine. A good separator will remove most of the small "junk," iron chips, etc., left in steam mains during erection, thereby preventing such material from reaching the engine cylinders or turbine inlet.

\* \* \*

### MACHINE TOOL SAFETY HANDLE

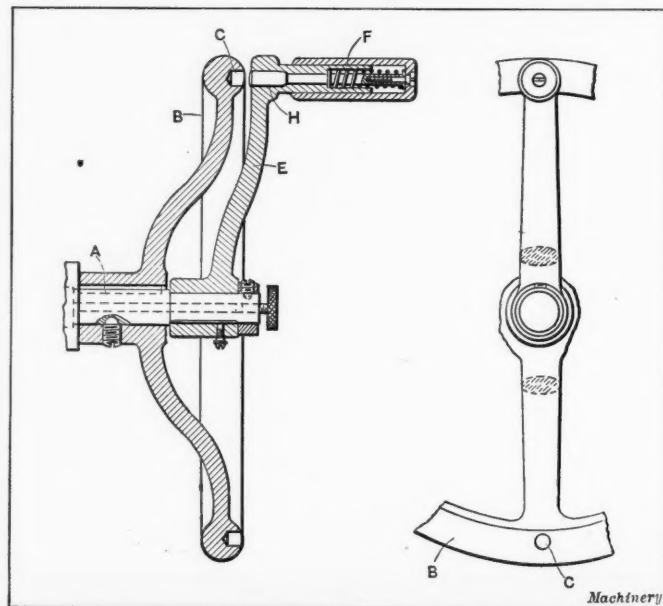
The accompanying illustration shows an arrangement recently patented by Alfred Herbert, Ltd., Coventry, England, for rotating the shafts of machine tools by hand, particularly where the shaft is also at times rotated by power, as in the case of milling machines, etc. To enable delicate adjustments of the shafts to be obtained, it is desirable that a handwheel be fitted to the shaft, and for quick winding a crank with a handle is preferable. In the arrangement illustrated, the crank is mounted outside the handwheel and the handle moves axially to engage the handwheel. To the shaft *A* is fixed a handwheel *B*, the rim of which is provided with a number of notches or holes *C*. On the shaft is loosely mounted a crank *E*, the outer end of which carries a handle *F* which can be caused to engage



Figs. 30-37. Application of Special Fittings to avoid Water Pockets

the boilers to prime during momentary heavy demands for steam, which quite frequently occur during peak-load periods. By using steam separators of the "receiver" type, having a capacity three or four times that of the high-pressure cylinder, it is possible to reduce the size of the engine supply pipe to one or two sizes smaller than the one called for by the engine builders. This reduction in pipe size should be made at the inlet side of the separator, or the pipe connecting the header with the separator. The pipe connecting the separator with the engine should be the same size as specified by the engine builder, the reason for this being that the steam flow is almost constant in the pipe supplying the separator, while the steam flow is intermittent in the pipe connecting the separator with the engine due to the cut-off in the steam chest. This does not apply to steam turbines, as the conditions under which they operate are different. The flow of steam is more nearly uniform throughout; therefore the pipe should be the same size at the inlet and discharge sides of the separator, and should be made the size called for by the turbine manufacturers.

Mechanics are sometimes careless in erecting new pipe work, frequently leaving bolts, nuts, wrenches, cold chisels, oil cans and even old shoes and overalls inside the piping system as the sections of pipe are being bolted together. The writer has seen mechanics hiding away tools, old shoes and overalls in the open end of a pipe (pushed in arm's length to hide them from view) when quitting work for the day. If the mechanic neglects to return in the morning and remove his belongings, the steam fitters are apt to bolt on four or five additional lengths of pipe, with the result that the operating engineer makes the acquaintance of the mechanic's "loose junk" some few months later, when called upon to take down and repair



Machine Tool Safety Handle

with the holes in the rim of the handwheel by means of a sliding pin *H* contained within the handle grip and pushed into place when the handle grip is slid towards the crank. It will be seen that as soon as the grip is released the catch becomes disengaged and the handle is freed from the wheel, which may continue to revolve or not. The wheel is always ready for operation to engage for minute adjustments and the effort required by the operator is very small.—*Mechanical Engineer.*

\* \* \*

In working to limits of one-ten-thousandth inch the thickness of the oil film in bearings is a factor to be reckoned with. In fact under certain conditions the oil film must be eliminated and metal-to-metal contact established. When journals are rotating under pressure this means the use of ball or roller bearings of a high degree of perfection. Metal-to-metal contact with a high-grade ball bearing is possible both for radial and axial thrusts.

## MACHINE FORGING—2

MACHINES AND METHODS EMPLOYED IN THE MANUFACTURE OF BOLTS, RIVETS, NUTS, MACHINE PARTS, ETC.

BY DOUGLAS T. HAMILTON\*

In the type of bolt and rivet making machines described in the first installment of this article, the head was formed by hitting the heated bar on the end and forcing it into suitably shaped impressions in the gripping dies. In the following, attention will be given to a type of bolt heading machine in which the end of the bar is first upset and the head is then formed to the desired shape by the combined action of the upsetting punch and hammer dies operating from all four sides. This article will also deal with the construction and operation of continuous-motion bolt and rivet making machines, both of the hand-feed and automatic-feed types.

## Hammer Type of Bolt Header

In the hammer type of bolt header, shown in Figs. 19, 20 and 21, the head of the bolt is formed by an end-working upsetting punch and four hammers which are operated from all four sides at right angles to the axis of the bolt. In operation, the heated blank, which has previously been cut to length,

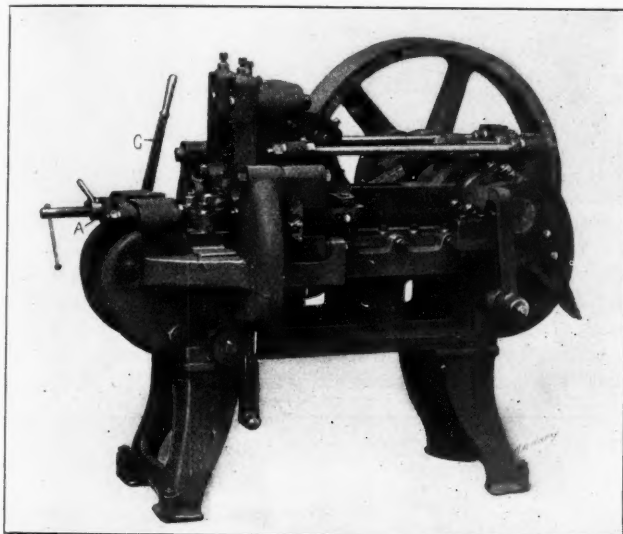


Fig. 19. Type of Hammer Header made by the National Machinery Co., Tiffin, Ohio

is placed in a seat (when the bolt is long enough to be thus accommodated) and between the gripping dies, being located lengthwise by the adjustable stop A. Then by a movement of the hand-lever C, the dies (one of which is shown at B in Fig. 21) are closed and the machine is started. The stock is not moved during the forging operation, but butted up against the

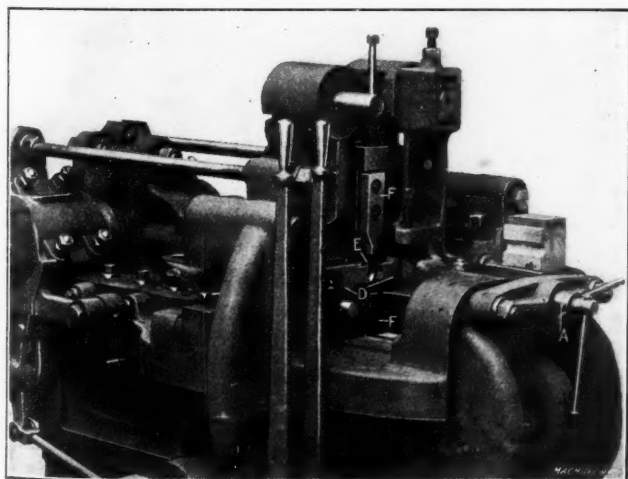


Fig. 20. View of Hammer Header showing Both Gripping Dies removed, and One Die Hanger

adjustable stop, and the gripping dies are not opened until the head is completely formed. From three to five blows are struck, depending upon the size of the bolt and the finish desired, whereupon the machine is stopped and the dies are opened by operating the hand-lever, allowing the finished work to drop from the machine. The side-forming hammers D,

Fig. 20, give two blows to every blow struck by the heading tool E and the vertical hammers F.

The 1½-inch size of this type of hammer header is provided with two hand controlling levers, as shown in Figs. 20 and

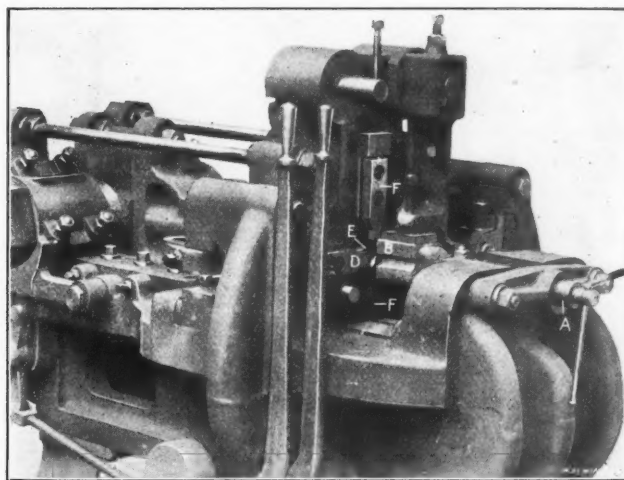


Fig. 21. View of Hammer Header showing Left-hand Die Hanger removed, and One Gripping Die in Place

21. One of these levers operates the arms carrying the gripping dies, and the other operates the clutch for starting and stopping the machine. On the smaller sizes of machines, one lever controls both of those movements. Fig. 20 shows one of these hammer headers with the gripping dies removed and also the left-hand gripping die hanger; this view also shows clearly the upsetting punch and the four forming hammers. Fig. 21 shows the same machine with one of the gripping dies in place and the left-hand gripping die hanger removed. The tools used in this machine are more clearly illustrated in Fig. 22;

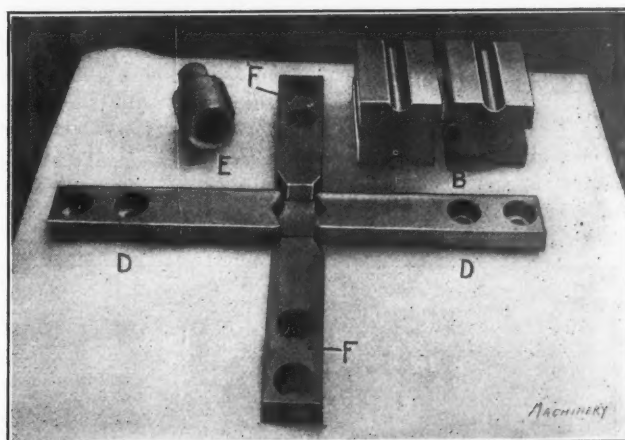


Fig. 22. Type of Dies, Hammers and Heading Tool used in the Hammer Type of Bolt Header shown in Fig. 19

the various members bear the same reference letters as used in connection with the description of the machine. For making a square-headed bolt, the side-working hammers, of course, are of the same shape as the vertical hammers.

The type of hammer header illustrated in Figs. 19, 20 and 21 is limited in its scope to the production of square, hexagon and tee-head bolts as shown in Fig. 23. These, however, can be produced in large quantities at a low cost, and what is more important, the product is entirely free from fins and burrs, and is shaped as accurately as is possible by the forging method. The fact, however, that it takes longer to change the dies from one size to another in this type of machine militates against its installation in preference to the other types of bolt headers, where frequent changes in the sizes of dies are necessary.

## Continuous-motion Bolt and Rivet Headers

Continuous-motion bolt and rivet headers are made in two types, one being hand-fed and the other provided with an automatic roll feed. A machine of the hand-fed type is shown

\*Associate Editor of MACHINERY.

In Fig. 24. In operating this type of machine, the bar, which has been heated for a length of four or five feet, is fed through a shear in the faceplate block of the machine, and as the movable gripping die closes on the bar, a blank of the required length is cut off and held rigidly in the gripping dies. The head is then formed by the forward movement of the ram which carries the heading tool. After heading, the ram of the machine recedes, the gripping dies open, and a kicker, actuated by a connecting-rod *c* from a cam on the main shaft, ejects the finished work from the dies, depositing it through a chute into a box. As the dies open, the operator again pushes in the heated bar until it strikes the stop, and as the movable die advances, another blank is cut off and headed as before. The machine runs continuously until the heated portion of the bar has been exhausted, when the operator takes a freshly heated bar from the furnace and proceeds as before.

A bolt or rivet made in a machine of this type receives only one blow, but for work within the capacity of this machine, the production is greatly increased over that ob-

by heel clamps as shown in Fig. 24. They are provided with four grooves making them interchangeable, so that when one groove wears out, it is only necessary to reverse the blocks. The heading punch *C*, which is held in the holder *D* in the ram of the machine, is cupped out to suit the shape of the bolt or rivet head, and is arranged so that it will be in perfect align-

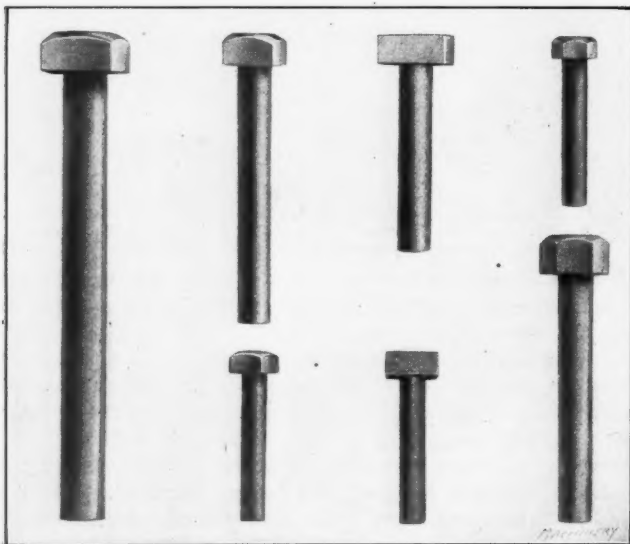


Fig. 23. Some Examples of Work produced in National Hammer Headers

tained from the plain type of forging machine. One of the chief requisites in a machine of the continuous-motion type is that of securing a rigid grip on the work while the head is being formed. If the grip is not satisfactory, that is, if the dies separate, it causes the shank of the bolt or rivet to become tapered or out of round, and also results in fins being produced on the shank and under the head. Furthermore, unless the machine is provided with suitable slides which

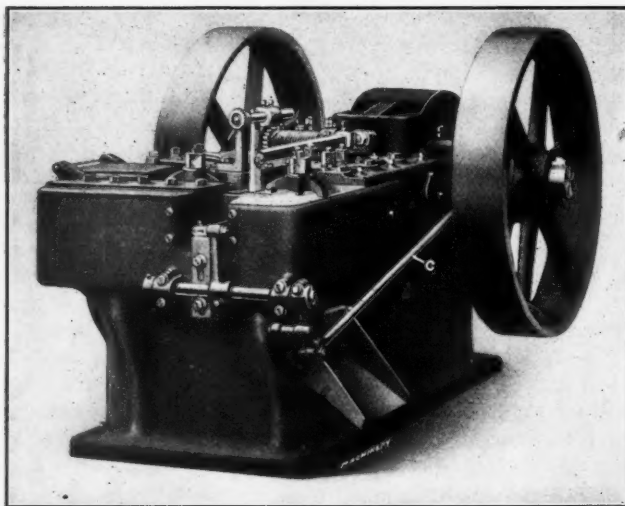


Fig. 24. Continuous-motion Wedge Grip Bolt and Rivet Header built by the National Machinery Co.

can be kept in proper alignment, it is difficult to secure work on which the heads are centrally located with the shanks, and also to keep the shear and movable die in correct working relation.

The type of tools used in the bolt and rivet machine of the continuous-motion type is illustrated in Fig. 25. The two gripping dies *A* and *B* are held in the die space of the machine

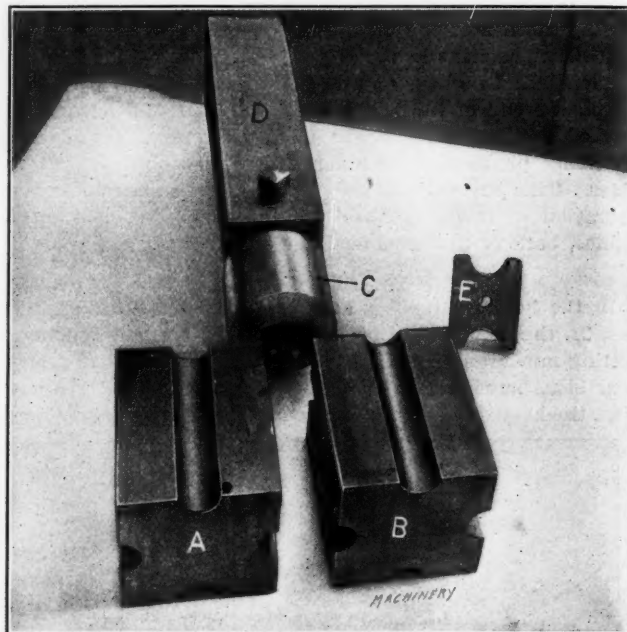


Fig. 25. Type of Dies and Tools used in the Continuous-motion Bolt and Rivet Header shown in Fig. 24.

ment with the gripping dies. *E* is the shearing blade which is held in the faceplate block, and is used in cutting off the stock to the desired length. The length of the gripping dies is governed by the length of the bolt required; they are made shorter than the blank from which the bolt is made, thus

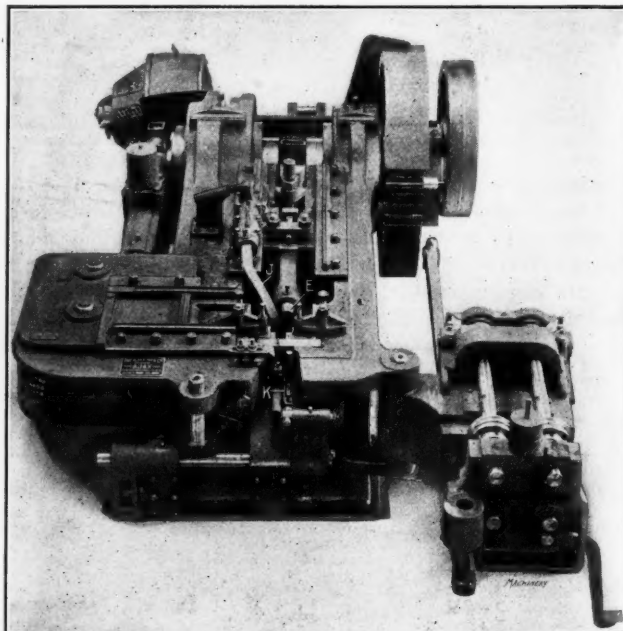


Fig. 26. Continuous-motion Bolt and Rivet Header built by the Ajax Mfg. Co., Cleveland, equipped with Roll Feed Attachment

allowing for sufficient extra stock to form the head. This subject will be dealt with more fully in a future article.

#### Continuous-motion Bolt and Rivet Header with Automatic Feed

Fig. 26 shows a continuous-motion bolt and rivet header furnished with a roll feed attachment, which, as can be seen, consists of four rollers provided with suitably shaped grooves in their peripheries. This view shows the roller feed attachment swung back out of the way to illustrate the dies and tools clearly. This machine is similar to that shown in Fig. 24, with the exception of the roll feed attachment for handling the bars automatically. The tools used are shown in Fig. 29, together with an example of work produced in them. The

shearing die *A*, in this case, is steel bushed and is circular instead of oblong in shape. The gripping dies *B* and *C* are provided with four grooves each, as previously described, but to change the blocks for presenting a fresh groove, they are inverted and turned end for end, there being no grooves in the top faces. *D* is a  $\frac{3}{4}$  by 4 inch track bolt, and *E* is the heading tool that is held in the ram of the machine.

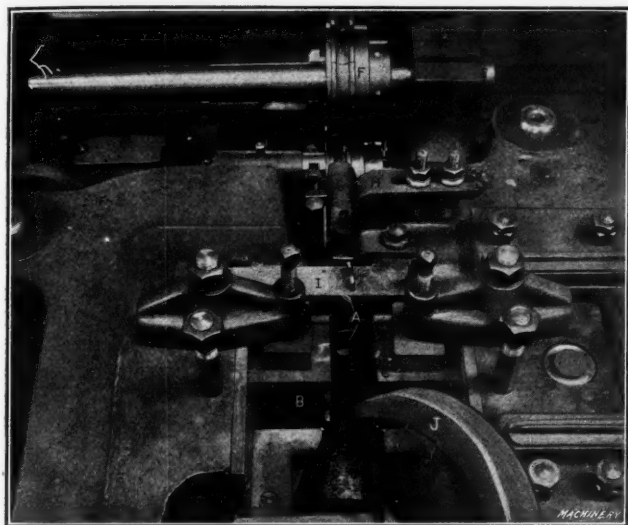


Fig. 27. View looking down into Die Space of Ajax Continuous-motion Bolt and Rivet Header

A close view looking down into the die space of the machine shown in Fig. 26 is illustrated in Fig. 27. This view shows clearly the relative positions of the feed rolls, shearing die,

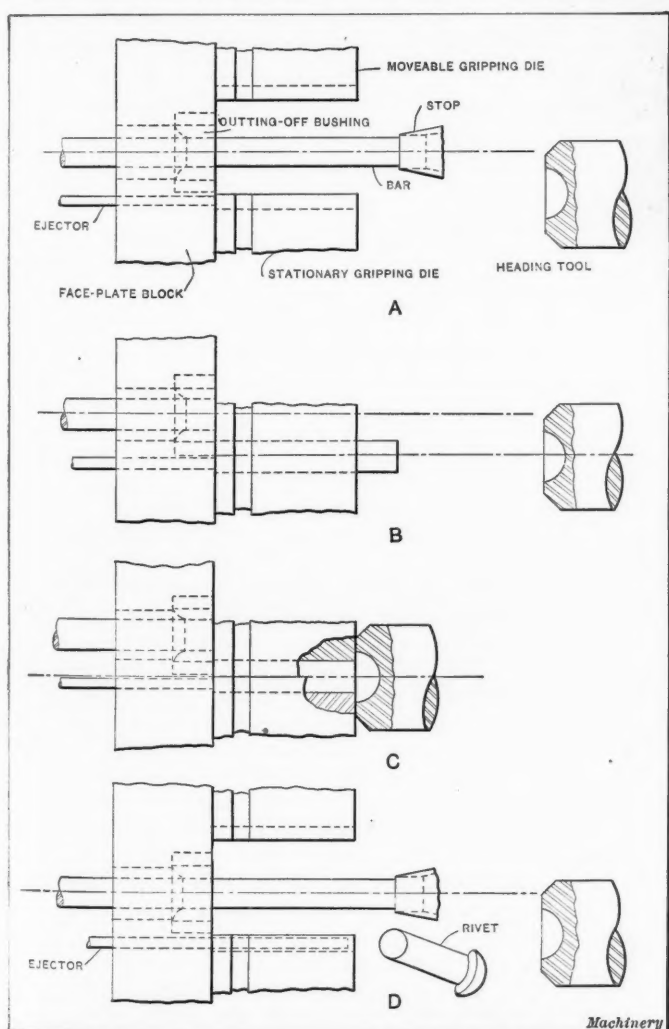


Fig. 28. Successive Steps in the Formation of a Round-head Rivet in a Single-blow Rivet Machine of the Continuous-motion Type

gripping dies, etc. The heated bar is fed by the rolls *F* through the guide pipe *G*, held by bracket *H*, and through the shearing bushing *A*. This bushing is retained in the faceplate *I* which is held in grooves in the machine bed. The bar is fed directly through the cut-off bushing *A* and is gaged to length by the

swinging stop *J*, see Fig. 26. The movable die *C* then advances, cuts off the blank and carries it into the groove in the stationary die *B*, gripping it while the heading tool *E* advances and upsets the end of the bar forming the head. The

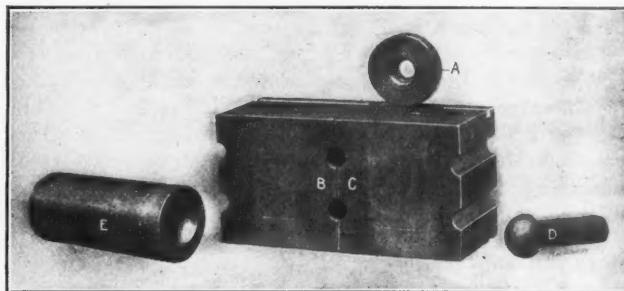


Fig. 29. Type of Dies and Tools used in Bolt and Rivet Making Machine shown in Fig. 26

stationary and movable gripping dies are held in place by straps, as shown in Fig. 27, and are located by tongues fitting in grooves in their lower faces. The length of feed is governed by the travel transmitted to the rolls through the feeding mechanism, which receives power from the main crank-

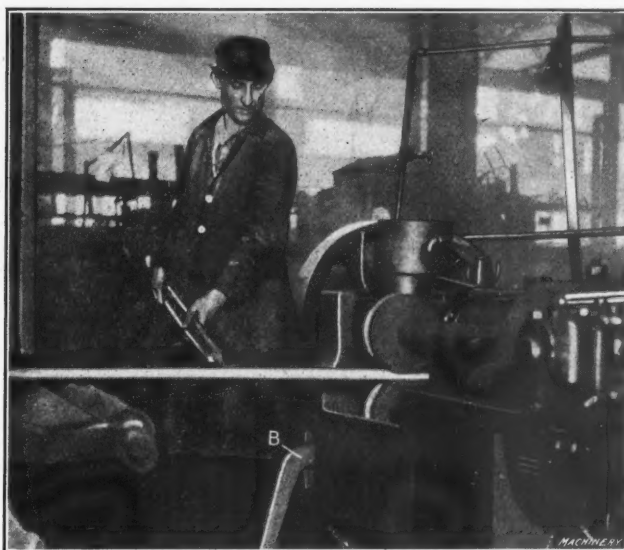


Fig. 30. Ajax Continuous-motion Bolt and Rivet Machine in Action making  $1\frac{1}{2}$ -inch Rivets

shaft through a connecting-rod, ratchet, pawl, gears, etc., and is adjustable at the will of the operator.

The various steps in the production of a round-head rivet by the continuous-motion single-blow bolt and rivet machine,

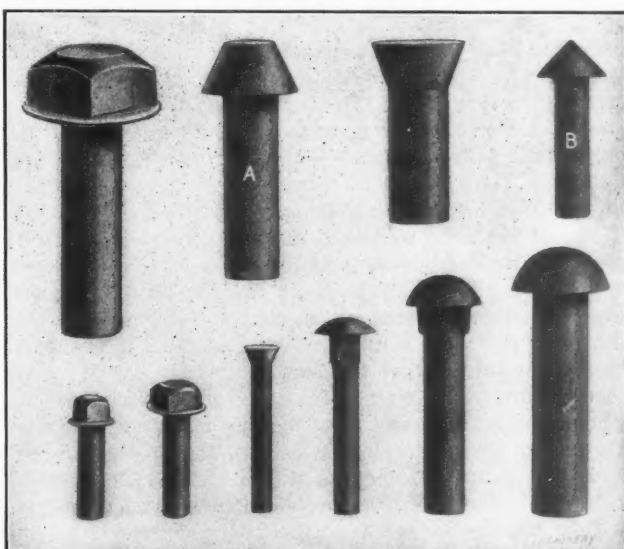


Fig. 31. Some Examples of Work which come within the Range of the Continuous-motion Type of Bolt and Rivet Headers

are clearly illustrated in the diagram Fig. 28. At *A*, the feed rolls have operated and have fed the heated bar out against the gage stop; at *B* the movable die has advanced, sheared off the end of the bar (projecting through the shearing bushing) and carried the blank into the groove in the stationary die. When the blank is held rigidly, or in other words, when the

movable die has reached the end of its forward movement, the heading tool advances, as shown at *C*, and upsets the end of the bar, forming the head. At *D*, the movable die and heading tool have retreated, the ejector pin (see *K*, Fig. 26) has advanced, pushing out the completed rivet, and the bar has been fed out again ready for a repetition of the operations.

Some idea of the methods pursued in the making of bolts and rivets by the continuous-motion machine process can be obtained from Fig. 30, which shows an operator attending to one of these automatic machines. The furnace in which the bar is heated (in the condition in which it comes from the mill) is located anywhere from  $3\frac{1}{2}$  to 4 feet from the feed rolls of the machine, and is provided with a roller *A* over which the heated bar passes. The heating furnace, as a rule, is 30 feet long so that the entire length of bar can be accommodated.

As soon as the bar in the furnace has reached the proper temperature, the operator grips it with a pair of tongs, as indicated in Fig. 30, draws it out, and places it between the feed rolls. Then he presses down the foot-lever *B*, thus starting the machine. The heated bar is then drawn in by the rolls, fed through the cutting-off die, gripped in the gripping dies, headed and ejected at the rapid rate of forty to seventy

pieces per minute. The operator watches the pieces as they drop from the machine, and then adjusts the stop to keep the work as uniform as possible—having a full head and without flash.

The feed rolls in the machine shown in Fig. 32 are made of chilled iron castings, and are kept cool by water jackets, insuring even temperature and minimum wear. They are operated from the main shaft of the machine, through a ratchet feed, by a connecting-rod as shown, which is adjustable for securing variations in the feeding time of the rolls. The movements of the machine are timed so as to allow the gripping dies to remain open a comparatively large part of the revolution, thereby allowing more time for the stock to be fed in and gaged and the dies to be well flooded and cooled at the completion of each stroke.

#### Examples of Continuous-motion Bolt and Rivet Work

Inasmuch as only one blow can be struck in a continuous-motion bolt and rivet making machine, it is impossible to produce parts which cannot be completed in one blow. Fig. 31 shows a representative group of bolts and rivets for which the continuous-motion machines are especially adapted. These machines will also handle a great variety of special work, such as square and hexagon head single-blow bolts, track bolts, etc. The cone-shaped rivets *A* and *B* illustrate the point mentioned in a previous paragraph regarding the difficulty encountered in producing work which is carried down far into the heading tool. Of course, these are not by any means extreme examples, but they serve to illustrate the point.

#### Making Bolt and Rivet Dies

Bolt dies which are used in a forging machine are as a rule made from steel containing from 60 to 80 points carbon, and are hardened and drawn. The gripping dies are tempered hard, so that the sharp corners on the edges of the dies will not wear away rapidly. It is customary to harden these dies in either oil or water, and then draw the temper so that a file will just take hold. The heading tool, which is comparatively small in diameter, and is called upon to perform heavy duty, must be much tougher than the gripping dies. Ordinarily the heading tool is made from a tough steel containing from 40 to 50 points carbon, and is drawn considerably more than the gripping dies.

In making the impressions in the gripping dies for heading ordinary sizes of bolts, no allowance is made for the shrinkage of the metal. However, in drilling the hole in the dies which grip the stock when it is being headed, a liner is placed between the two halves of the die, so that when they come together on the stock, the latter will be securely held. For dies with a  $\frac{1}{4}$ - to  $\frac{5}{8}$ -inch hole, a liner  $\frac{1}{64}$  inch thick is placed between the opposing faces, when drilling the hole. For holes larger than  $\frac{5}{8}$  inch and up to 1 inch, a liner  $\frac{1}{32}$  inch thick is used. For bolt dies from 1 inch up to  $1\frac{1}{2}$  inch in diameter, a liner  $\frac{3}{64}$  inch thick is used, and from  $1\frac{1}{2}$  inch up to and including 3 inches in diameter, a grip of  $\frac{1}{16}$  inch is allowed. Double-deck type dies are made from six blocks of steel bolted and keyed together to facilitate machining.

In making bolt and rivet dies, which are used in continuous-motion machines, it is customary when making ordinary sizes of rivets from  $\frac{1}{2}$  to 1 inch in diameter, to use bar stock which is rolled  $\frac{1}{64}$  inch under size. The dies referred to are shown in Figs. 25 and 29. The holes in the gripping dies are drilled to exact size (not  $\frac{1}{64}$  inch under size, which is the diameter of stock used), and the expansion of the iron in heating gives sufficient grip as it is only necessary to prevent the rivets from being pulled out of the dies by the return stroke of the heading tool. The reason for this is that in the continuous-motion type of bolt and rivet machine, the work is supported on the sides by the gripping dies, and is backed up by the shear, so that it is practically held in a box while the head is being formed. The same grade of steel is used for making rivet tools as for making tools for producing bolts, and the heat-treatment is also carried on in a similar manner.

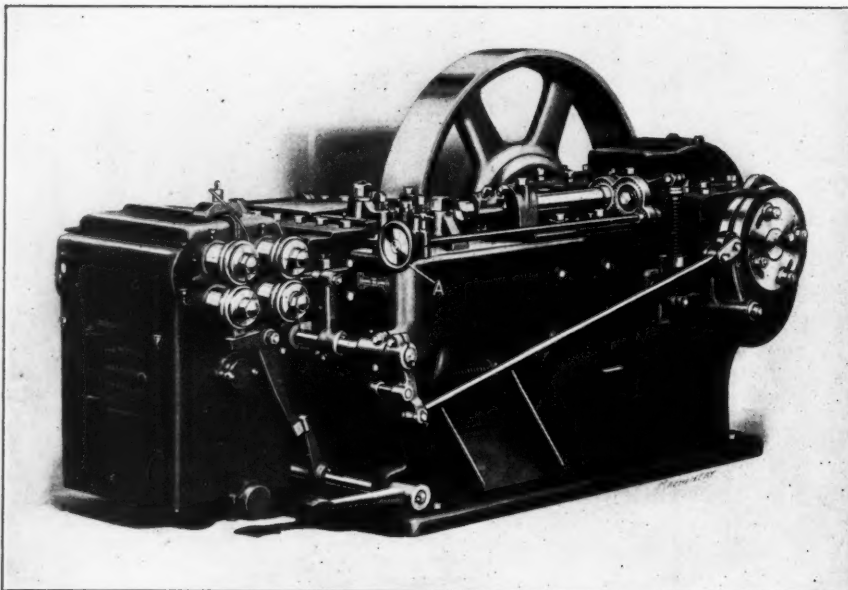


Fig. 32. National Continuous-motion Bolt and Rivet Making Machine equipped with Roll Feed and Adjustable Stop Gage

pieces per minute.

In the manufacture of rivets, as a rule, steel containing from 10 to 12 points carbon is more frequently used than wrought iron, although the latter material is used in considerable quantities in some manufacturing establishments. Wrought iron for making rivets is heated almost to a white heat, but steel which contains from 10 to 12 points carbon is heated to only about 1400 degrees F.—a bright red color. When the head of a rivet makes it necessary to carry the stock down far into the heading tool, the temperature to which the bar is heated has to be increased, in order to make the metal flow more readily and prevent buckling.

In making rivets having long tapered heads, the operator generally finds it necessary to change the length of feed, so that a rivet having a full head without flash is formed. The reason for this is that the bars sometimes vary in size and temperature which makes this adjustment necessary. A continuous-motion bolt and rivet making machine, which is provided with means for taking care of the fluctuations in size and temperature of stock, is shown in Fig. 32. In this machine the position of the stop is controlled by a handwheel *A*, within convenient reach of the operator, which he adjusts either way, depending upon the size of the bar, temperature of the metal, the shape of the part to be produced and the material from which it is made. When an over-size bar is encountered, the operator shortens the length of feed, as it is evident that too much stock would then be supplied. When the bar is under size, the reverse is the case. Again, when the bar is too hot, it is upset more on the end by the rolls forcing it against the stop, and of course more metal is pro-

EXHAUST SYSTEMS FOR GRINDING, POLISHING AND BUFFING WHEELS\*

SPECIFICATIONS PRESCRIBED BY THE NEW YORK STATE DEPARTMENT OF LABOR

The New York State Department of Labor has issued specifications for the design, construction and operation of exhaust systems for grinding, polishing and buffing wheels prepared by Mr. William Newell, mechanical engineer. The specifications were issued with the view of bringing about the efficient removal of dust from grinding and buffing wheels and preventing the construction of exhaust systems of faulty design. Faulty designs include (1) making the suction duct much too small and not infrequently of the same size throughout its length; (2) running the branch pipes into the main at right angles and sometimes at the bottom of the main; (3) providing a fan too small for the service; (4) providing a discharge pipe too small for the fan; (5) providing a cyclone separator or dust separator too small for the system. The result of such mistakes in design is that the suction is entirely inadequate to carry off the dust which then clogs the ducts and spreads about the room to the detriment of the workmen's health.

The importance of efficient exhaust systems is obvious as regards the preservation of health and proper working conditions. An efficient system is productive of higher efficiency of both men and machinery. It has been proved time and time again in actual practice that the output of workmen working under healthy atmospheric conditions is higher than when the conditions are bad. Freedom from dust promotes longer life of machinery and reduces fire risk. The following specifications for the design, construction and operation of exhaust systems conform to Section 81 of the Section Labor Law of New York State.

TABLE I. MINIMUM SIZES OF BRANCH PIPES ALLOWED FOR DIFFERENT SIZED EMERY OR OTHER GRINDING WHEELS

Diameter of Wheels	Minimum Grinding Surface, Sq. Ins.	Minimum Diameter of Branch Pipe in Ins.
6" or less, not over 1" thick .....	19	3
7" to 9" inclusive, not over 1½" thick ....	43	3½
10" to 16" inclusive, not over 2" thick ....	101	4
17" to 19" inclusive, not over 3" thick ....	180	4½
20" to 24" inclusive, not over 4" thick ....	302	5
25" to 30" inclusive, not over 5" thick ....	472	6

1. In case a wheel is thicker than given in the above tabulation, or if a disk instead of a regular wheel is used, it must have a branch pipe no smaller than is called for by its grinding surface, as given above.

TABLE II. MINIMUM SIZES OF BRANCH PIPES ALLOWED FOR DIFFERENT SIZED BUFFING, POLISHING, OR RAG WHEELS

Diameter of Wheels	Maximum Grinding Surface, Sq. Ins.	Minimum Diameter of Branch Pipes in Ins.
6" or less, not over 1" thick .....	19	3½
7" to 12" inclusive, not over 1½" thick ...	57	4
13" to 16" inclusive, not over 2" thick ....	101	4½
17" to 20" inclusive, not over 3" thick ....	180	5
21" to 24" inclusive, not over 4" thick ....	302	5½
25" to 30" inclusive, not over 5" thick ....	472	6½

2. Buffing wheels six inches or less in diameter used for jewelry work may have a three-inch branch pipe. The thickness given for buffing wheels just above applies to the thickness of the wheel at the center. In case the wheel is thicker than given in the above tabulation, it must have a branch pipe no smaller than is called for by its grinding surface.

3. Branch pipes must be not less than the sizes specified in the foregoing throughout their entire length.

4. All branch pipes must enter the main suction duct at an angle not exceeding forty-five degrees and must incline in the direction of the air flow at junction with main.

5. Branch pipes must not project into main duct.

\* From specifications for the design, construction and operation of exhaust systems compiled by Mr. William Newell and published by the New York State Department of Labor, 381 Fourth Ave., New York City.

6. All laps in piping must be made in the direction of the air flow.

7. All bends, turns, or elbows, whether in main or branch pipes, must be made with a radius in the throat at least equal to one and one-half times the diameter of the pipe on which they are connected.

8. The inlet of the fan or exhauster shall be at least twenty per cent greater in area than the sum of the areas of all the branch pipes, and such increase shall be carried proportionately throughout the entire length of the main suction duct, i. e., the area of the main at any point shall be at least twenty per cent greater than the combined areas of the branch pipes entering it between such point and the tail end or dead end of the system. If such increase is made greater than twenty per cent, the area of the main at any point, except that por-

TABLE III. DIAMETERS OF SUCTION DUCT WITH BRANCH PIPES

Number of Branch Pipes	Diameter of Branch Pipes in Inches							
	3	3½	4	4½	5	5½	6	7
	Area of each Branch Pipe in Square Inches							
	7.07	9.62	12.566	15.9	19.635	23.753	28.274	33.183
	Area of each Branch Pipe plus 20 per cent (square inches)							
	8.484	11.544	15.08	19.08	23.562	28.51	33.93	39.82
1	3½	3¾	4½	5	5½	6	6½	7½
2	4½	5½	6½	7½	8½	9½	10½	12½
3	5½	6½	7½	8½	9½	10½	11½	13½
4	6½	7½	8½	9½	10½	11½	12½	14½
5	7½	8½	9½	10½	11½	12½	13½	15½
6	8½	9½	10½	11½	12½	13½	14½	16½
7	9½	10½	11½	12½	13½	14½	15½	17½
8	10½	11½	12½	13½	14½	15½	16½	18½
9	11½	12½	13½	14½	15½	16½	17½	19½
10	12½	13½	14½	15½	16½	17½	18½	20½
11	13½	14½	15½	16½	17½	18½	19½	21½
12	14½	15½	16½	17½	18½	19½	20½	22½
13	15½	16½	17½	18½	19½	20½	21½	23½
14	16½	17½	18½	19½	20½	21½	22½	24½
15	17½	18½	19½	20½	21½	22½	23½	25½
16	18½	19½	20½	21½	22½	23½	24½	26½
17	19½	20½	21½	22½	23½	24½	25½	27½
18	20½	21½	22½	23½	24½	25½	26½	28½
19	21½	22½	23½	24½	25½	26½	27½	29½
20	22½	23½	24½	25½	26½	27½	28½	30½
21	23½	24½	25½	26½	27½	28½	29½	31½
22	24½	25½	26½	27½	28½	29½	30½	32½
23	25½	26½	27½	28½	29½	30½	31½	33½
24	26½	27½	28½	29½	30½	31½	32½	34½
25	27½	28½	29½	30½	31½	32½	33½	35½
26	28½	29½	30½	31½	32½	33½	34½	36½
27	29½	30½	31½	32½	33½	34½	35½	37½
28	30½	31½	32½	33½	34½	35½	36½	38½
29	31½	32½	33½	34½	35½	36½	37½	39½
30	32½	33½	34½	35½	36½	37½	38½	40½

The foregoing duct table gives the diameter in inches of the main suction duct at any point for any number of uniform-size branch pipes when the area of the main at any point is made equal to the combined areas of the branch pipes preceding that point plus twenty per cent—the minimum required by these specifications.

tion of it between the branch entering it nearest the fan and the fan, shall bear approximately the same ratio to the combined areas of the branches preceding that point (i. e., between it and the tail end of the system), as the area of the main at the branch nearest the fan bears to the combined areas of all the branches. (This provision is made to permit the use of a fan having a larger inlet area than the area of the main at the branch pipe nearest to the fan, if desired.) See accompanying Table III, showing what the size of the main suction duct should be at any point for any number of uniform-size branch pipes when the main duct is made twenty per cent greater than the combined areas of the branches entering it—the minimum required by these specifications.

9. The area of the discharge pipe from the fan shall be as large or larger than the area of the fan inlet throughout its entire length.



come far enough forward beneath the front of the wheel so that the dust will enter the hood and not fall outside of it altogether, even if the accomplishment of this result necessitates leaving considerable space between the wheel and the lower part of the hood in order that the hood shall not interfere with the work.

10. Branch pipes should lead out of the hood as nearly as possible at the point where the dust will naturally be thrown into them by the wheels. This is very important.

11. An objectionable practice sometimes found where small work is polished is the use of a screen across the mouth of the branch pipe where it enters the hood. Such screens are an obstruction to the passage of material and the ravelings from buffing wheels are held against the screen by the suction, with the result that in a short time the draft is almost entirely cut off.

12. The use of a trap at the junction of the hood and branch pipe is good practice provided it is cleaned out regularly and not allowed to fill up with dust. This will catch the heavier particles and so take some wear off the fan. It will also serve to catch any nuts, pieces of tripoli, etc., dropped by accident, and in the case of work on small articles, will enable them to be recovered when dropped in the hood.

13. All bends, turns, or elbows, whether in main or branch pipes, should be made with a radius in the throat of twice the diameter of the pipe on which they are connected, wherever space permits.

14. Elbows should be made of metal one or two gages heavier than the pipe on which they are connected as the wear on them is much greater.

15. The withdrawal of air from a room by an exhaust system naturally tends to create a slight vacuum and for this reason inlets for air at least equal to the sum of the areas of the branch pipes should be left open.

16. Recommendations for the size of the cyclone separator or dust collector, as it is often called, are hard to give, as the separator must be proportioned to suit operating conditions, light dusts requiring a larger separator than heavy dusts. A separator should be selected the area of whose inlet is at least as large as the area of the discharge pipe from the fan. For light buffing dusts, lint, etc., the air outlet from the top of the separator should be so large that the velocity of discharge will not exceed 300 to 480 feet per minute; then select a separator of which the other dimensions are proportionate. The air outlet should be provided with a proper canopy or elbow to exclude the weather but should be otherwise unobstructed. There should be ample clearance under the separator for the accumulation or storage of the dust which should never be allowed to pile up as high as the bottom of the separator.

The accompanying illustration shows an exhaust system laid out in conformity with these specifications for eight fourteen-inch emery wheels. For eight fourteen-inch buffing wheels, the branch pipes would have to be not less than four and a half inches diameter, and the increased size of the main suction duct and the fan determined in accordance with Section 8. The main discharge pipe would also have to be larger and the cyclone separator should be considerably larger for buffing wheels than for emery wheels.

\* \* \*

### A NEW MACHINE FOUNDATION

BY J. P. SCHROETER\*

A very convenient method of foundation construction has recently been developed by the Rügen Machine Fundament Co., Berlin, Germany. This new method dispenses with all anchoring, bolting, etc., and the floor, consisting of concrete, wood or asphaltum, generally remains just as it is, although it must be leveled up when necessary. Between the machine foundation plate and the floor, an India rubber mat is laid. This mat is of special composition, and as a result of the weight of the machine acting upon it a vacuum is produced. The machine is held firmly in position by the displacement of the air and the adhesion of the mat, so that no anchoring or other means of fastening is necessary. This type of foundation is, of course, especially suitable for small machines, although it

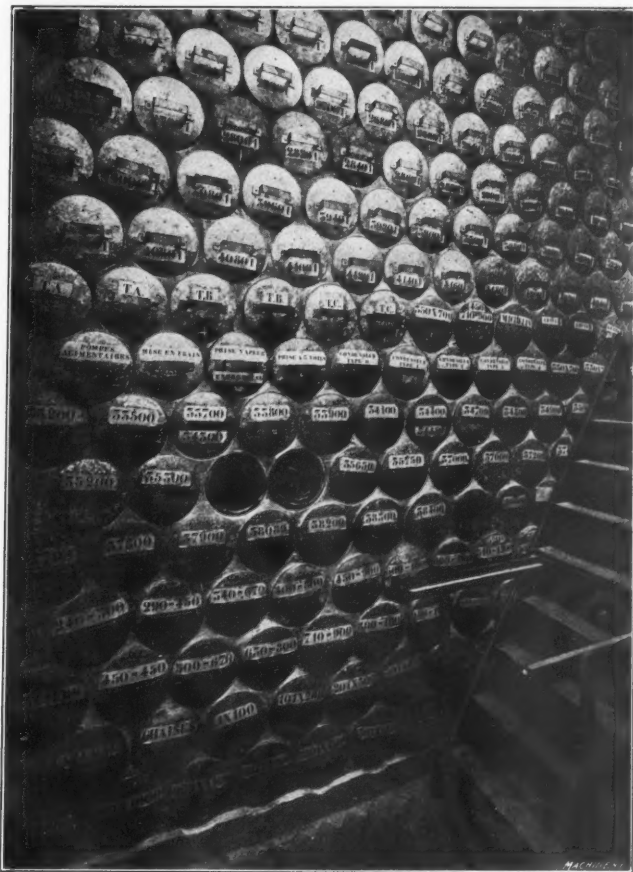
works well on large ones which have to be erected on a substructure. In such cases all that is necessary is a small layer of concrete with the foundation plate on the top.

The advantages of this new Rügen foundation are as follows: There is considerable saving in the expense of the foundation construction. A great saving in time is effected, as it is not necessary to wait for several days until the cement foundation has hardened. All damage to the floor or ceiling is avoided because the use of foundation bolts in the floor or stays from the ceiling is unnecessary. It is possible to remove the machine easily and inexpensively, if necessary. All shocks and noises are absorbed, which results in greater precision in manufacturing and an increased life of the machine. Electrical machines are entirely insulated so that no ground connections are possible. The rubber mats may be employed for the same purpose and with the same results in another place, in case the machines are removed. A great number of machines have been erected on this type of foundation in all industrial branches, and they have given the greatest satisfaction.

\* \* \*

### FIREPROOF VAULT FOR DRAWINGS

The illustration shows a unique storage vault for drawings, built by Société Anonyme des Ateliers de Construction, H. Bollinckx, Brussels, Belgium, which provides for the segregation of the drawings, and has the merit of being simple, cheap to construct and probably efficient in case of ordinary fire. The vault is designed for the protection of original drawings and tracings only. The drawings used by the company are 0m.80 by 1m.20 (31½ by 47¼ inches). The vault consists of rows of



Bollinckx Fireproof Storage Vault for Drawings

earthenware tubes set in concrete, one row above another as shown in the illustration. The tubes are inclined so that the mouths are slightly lower than the rear. This is done to prevent the easy entrance of water spray in case of fire. The mouths of the tubes are closed with sheet-iron lids on which the numbers of the drawings within are stenciled.

The ladder shown at the right is provided to enable all the tubes to be easily reached. It is made with two guides in front which carry a lattice (seen in the rear), on which to spread out the drawings when it is desirable to inspect them at the storage vault.

The company states that drawings kept in this vault are remarkably unchanged by age, the reason being ascribed to the regularity of temperature and the absence of light.

\* Address: 1321 E. 56th St., Chicago, Ill.

## MAKING THE RED-E TOOL-HOLDER

AN EXAMPLE OF SPECIALIZED MANUFACTURE IN WHICH BROACHING PLAYS AN IMPORTANT PART

BY CHESTER L. LUCAS\*

In the manufacture of tool-holders, it would not seem at first thought that there could be many specially interesting operations, but the way the Ready Tool Co., of Bridgeport, Conn., has applied modern methods to making good tool-holders has resulted in the use of interesting jigs and fixtures worthy of description. The Ready Tool Co. makes many different types



Fig. 1. Red-E Tool-holder "Type X"

of tool-holders for lathe and planer use, but the manufacture of its latest style, known as "Type X," furnishes interesting methods enough for one article. This tool-holder, which is shown in the phantom illustration, Fig. 1, is provided with a square hole at an angle of fifteen degrees with the base to receive the tool-bit. The tool-bit is held in place by a set-

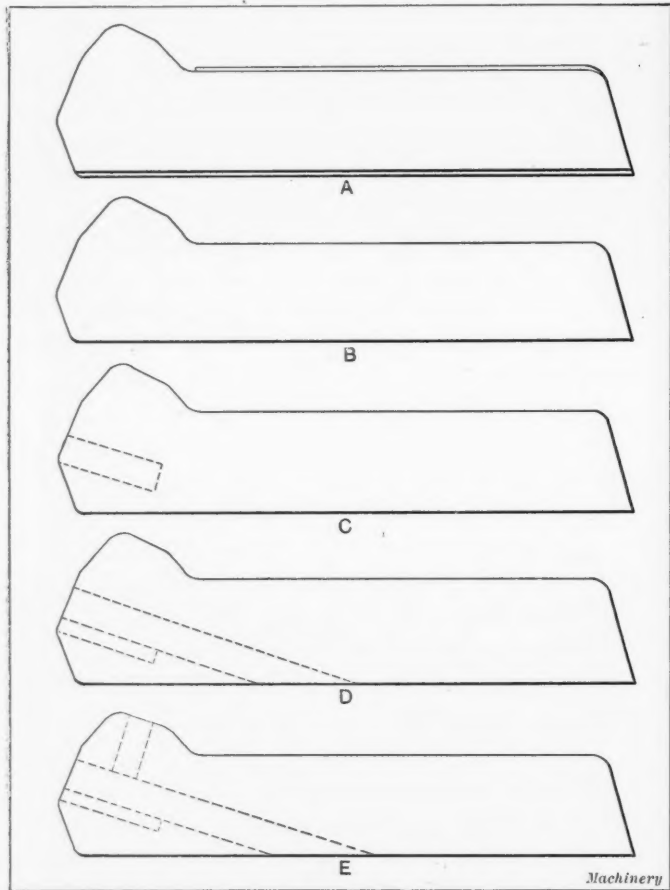


Fig. 2. Steps in making the Tool-holder

screw, bearing against it at right angles, and an important feature is the inserted tool-steel seat against which the tool-bit bears.

### Milling off the Edges

Fig. 2 gives an idea of the different operations through which the tool-holders pass before they reach completion. At A we have the drop-forging upon which the work starts. This is made of chrome-nickel steel, and the first operation is that of milling the flat top and bottom. This operation is necessary because the parting line of the forging comes along the edge of the tool-holder and the draft which the dies require leaves the edges of the forging convex. The special milling fixture illustrated in Fig. 3 is employed for milling off this convexity,

\*Associate Editor of MACHINERY.

and six tool-holder blanks are accommodated. By referring to Fig. 4 it will be seen how this fixture operates.

There are three units to the fixture, each of which is provided with a central stationary rib A, shown on the unit of the fixture illustrated in Fig. 4; against this central rib the forgings B are clamped from each side. The clamping jaws C are drawn against the forgings by means of a right- and left-hand screw D. The four contact points of jaws C are indicated at E. These parts are pivoted two in each of the jaws so that they can adjust themselves to any irregularities of the forgings. As the jaws C slide loosely over screw D, they also have considerable latitude in adjusting themselves to the clamping position. It should be noticed that the clamping jaws have a three-point bearing, the two upper points being at E and the lower point against the side of the fixture.

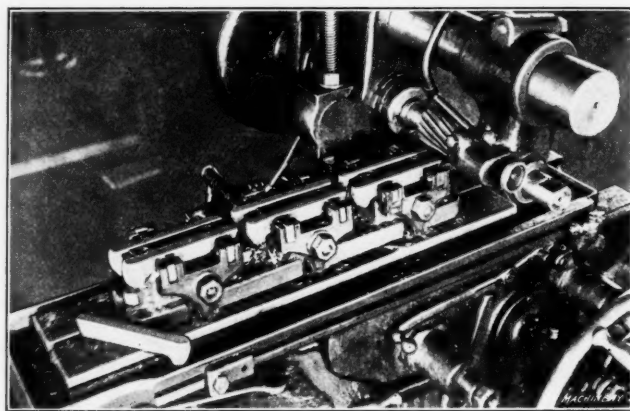


Fig. 3. Milling Fixture in which the Edges are machined

The operation of this fixture is rapid and efficient. By simply tightening the nut on the screw from one side, both forgings are securely clamped in place. The various bearing parts are, of course, hardened on their working faces.

### Drilling for the Tool-steel Plug

The result of the milling operation is shown at B in Fig. 2, and the succeeding step is that of drilling the end of the tool-holder for the reception of the tool-steel plug. After this plug has been welded in place, as will be described later, the upper half is drilled and broached away leaving a tool-steel seat, semicircular in section, against which the cutting strain of the tool-bit is received.

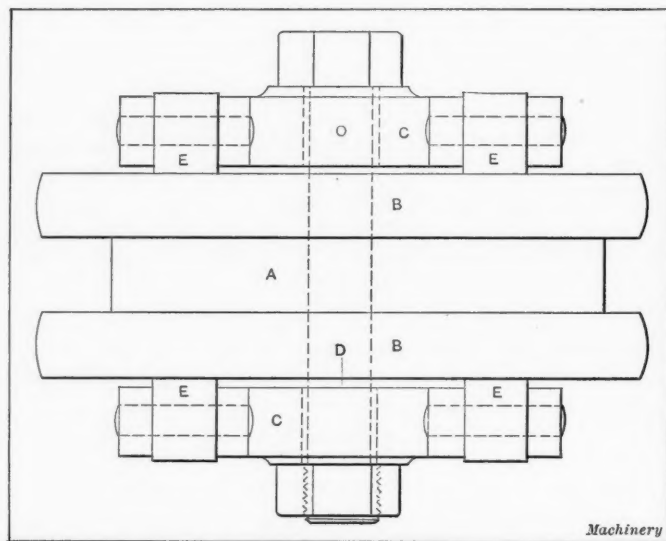


Fig. 4. Showing the Principle of Milling Fixture

The type of jig upon which the drilling of these holes is accomplished is extremely interesting, due to the fact that it is used for many different operations, of which the drilling for the plug is but one. One of these jigs is shown in Fig. 5, in

a vertical position at the left and in a horizontal position at the right. When used in the position, shown at the left, resting upon corners *A* and *B*, the hole for the tool-steel plug may be drilled in the right-hand off-set tool-holders. By simply swinging the jig over, as on a pivot, so that it rests upon corners *B* and *C*, it is in position for drilling the plugs in the left-hand off-set tool-holders. The forgings are held in the jig by means of two clamps *D* which bear against the edge of the tool-holder, and a clamp *E* which bears against the side of the tool-holder. When drilling right-hand off-set tools, the bushing *F* is used, and when drilling left-hand off-set tools bushing *G* is in use. This jig is used for all the drilling opera-

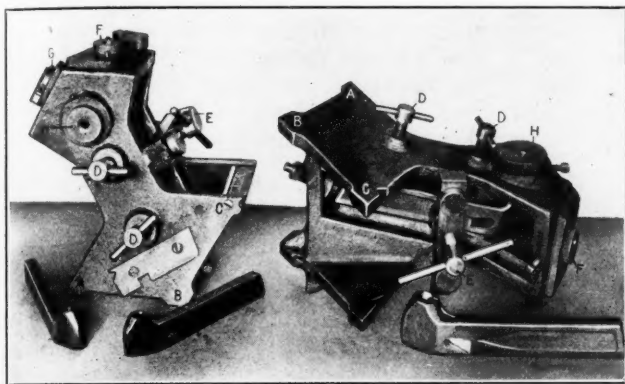


Fig. 5. Drill Jig, illustrating Both Positions

tions on the off-set tool-holders; there are three of these operations and the other two will be described later. The straight-shank tool-holders are drilled in a jig of simple design which is shown in use in Fig. 6. The tool-holders are clamped in position in the same manner as in the previous jig.

#### Welding the Plug

As has been stated before, after the drilling of the tool-holder for the insertion of the tool-steel plug the tool-holders go to a Thomson electric welding machine to have the plugs welded in position. This machine works on the same principle as other Thomson electric welding machines and is shown as a whole in Fig. 7. Referring to this illustration and Fig. 8, which shows the working parts of the machine at close range, *A* is the tool-holder into which the plug is being welded. The plug is shown in place, and at *B* may be seen another plug. The electrodes of the machine are represented by *C* and *D*. These electrodes are kept cool by a circulation of water through pipes *E*. The upper electrode *C* is supported in a

the plug, so that there is plenty of metal to press against the plug without altering the finished shape of the tool-holder.

The drilling of the hole for the tool-holder bit, which takes place after the tool-steel plug has been welded in position, is performed on the jig illustrated in Fig. 6. This jig, it will be remembered, is the same one that was used for drilling the holes for the plugs. To prepare the jig for this operation, it is only necessary to turn the bushing a half turn and clamp it solid again by means of simple clamps provided. As the holes in these bushings are off-set, when located in one extreme position they are properly located for drilling the plug, and when turned to the other extreme are so situated that they drill away one-half of the plug and thus form the correct location for the tool-bit hole. This jig is used only on the straight tool-holders, the off-set types being taken care of by the jig shown in Fig. 5. When using the jig for this operation, bushings *F* and *G* are given a half turn and again clamped, and the jig is ready for use.

This drilling operation is particularly hard on the drill as it will be remembered that half the hole being drilled is through the tool-steel plug, while the other half is through the

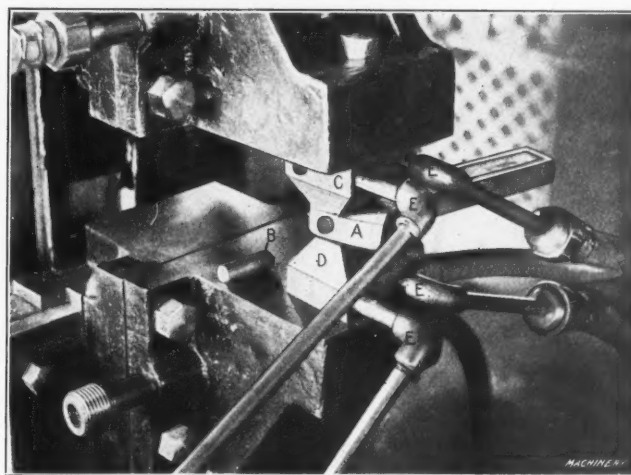


Fig. 8. Welding the Plug in Place

chrome-nickel steel forging, and as this division is made longitudinally there is a tendency for the drill to "run." Also by referring to *D* in Fig. 2, which shows the plugged and drilled tool-holder, it will be noticed that this hole emerges from the under side of the forging at an angle so that the drill is under more strain when breaking through. The drills used are of the hot twisted type.

#### Broaching the Square Hole for the Tool

One of the most interesting operations connected with the manufacture of the "Red-E" tool-holder is that of broaching the square hole. This operation is performed on a broaching machine made by the J. N. Lapointe Co., New London, Conn., and has been conceded by broaching experts to be a most difficult proposition. The difficulty lies in the fact that the square hole is of small diameter and must be broached to the limit of the corners, and in addition, the length of the hole is great in comparison with the diameter. The fact that the cut is at an angle with the base of the tool-holder gives more trouble, because the cut is longer on one side of the hole than on the other. In Fig. 9 a general view of the broaching operation is illustrated, and in Fig. 10 a closer view of the working parts of

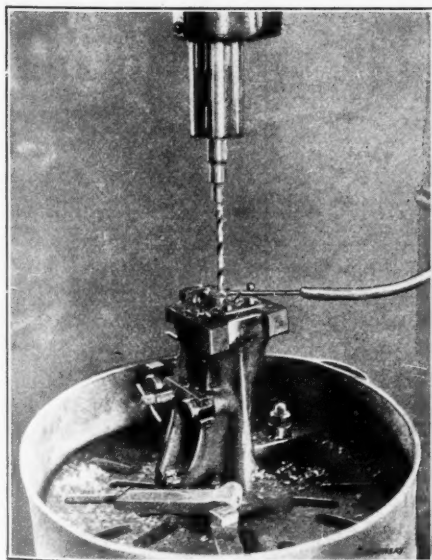


Fig. 6. Drilling for the Tool-steel Plug

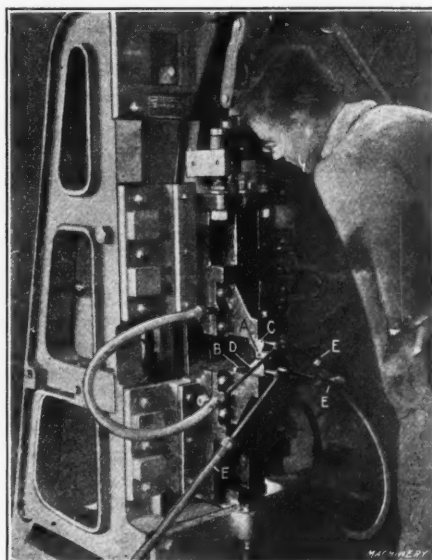


Fig. 7. Thomson Electric Welding Machine

movable slide so that when the tool-holder and plug have reached the welding heat it can be pressed down upon the side of the tool-holder, compressing the metal in the tool-holder against the steel plug and causing them to unite. The slide is operated by means of a toggle mechanism and lever *F*, shown in Fig. 7, which is actuated by the operator. It should be stated that the forgings are adapted for this welding operation by leaving the sides very full at the points opposite

the machine and broaching fixture is shown. Two types of jigs are used for broaching the square holes, the one shown at the left in Fig. 11 being employed for the straight tool-holders, while that at the right is used for the off-set tool-holders, both right- and left-hand. These fixtures are designed to be bolted to the faceplate of the broaching machine after the manner illustrated in Fig. 10. The tool-holders are held in position from both sides by clamping screws, as may be

clearly seen in Fig. 11. Stops are provided to gage the position of the tool-holders with respect to the previous drilling operation, for it is essential that the broaches cut evenly at the corners of the drilled holes. The broaches themselves are shown in the foreground of this illustration. They are three in number. The first broach starts from the round and cleans out part of the metal from the corners; the second approaches the square still more; and the third completes the work, sizing and finishing the hole entirely. On most square broaching jobs the corners may be left with slight fillets, but on this work the metal must be removed right in to the corner. In Fig. 11, an off-set and a straight tool-holder may be seen. Of these two, the straight holder is more difficult to broach because of the long length of hole.

Fig. 12 illustrates the method used in making the broaches. Round steel is employed for the broach blanks and the first operation consists in cutting the teeth. These are turned by holding the broach in a collet, turning several teeth, and then

drilling operations which may be performed upon this one type of jig.

The tool-holders are now finished by putting them through a casehardening process which hardens the tool-steel seat and at the same time the case of the entire tool-holder. After the tool-holders pass through this process they are hard enough to withstand the rough use they are likely to get. The hardening process imparts the familiar mottled blue finish when wanted, but the company has lately been sending out its tool-holders with a new "spring blue" finish.

\* \* \*

#### LIGNITE AS A LOCOMOTIVE FUEL

It is possible that lignite will become an important locomotive fuel in those sections of the country where coal is not available. The International Railway Fuel Association has appointed a committee to report on this subject at its annual convention in Chicago next May. The American

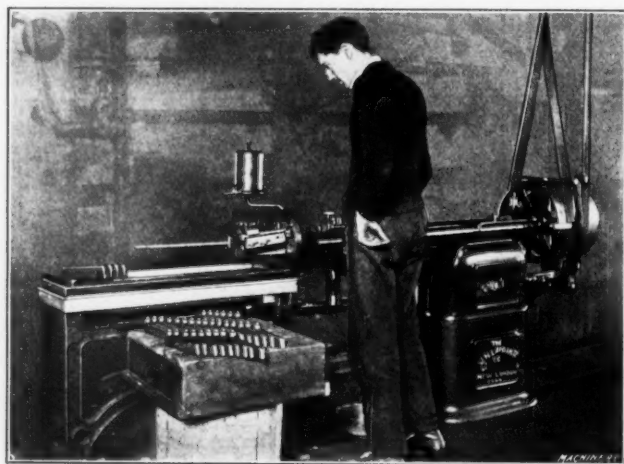


Fig. 9. Broaching the Square Hole

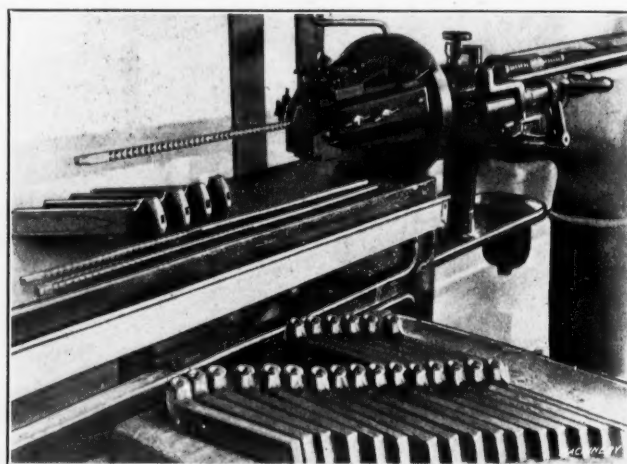


Fig. 10. A Closer View of the Broaching Operation

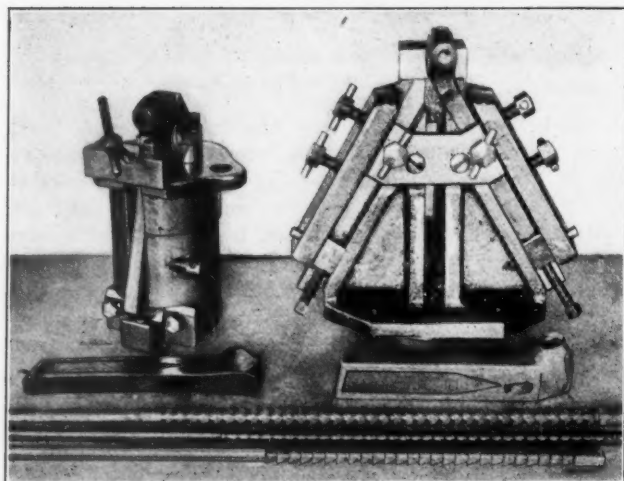


Fig. 11. Fixtures used in broaching Straight and Off-set Tool-holders

advancing the work for turning a few more teeth. After the teeth have been turned the broach is mounted in a milling machine as illustrated in Fig. 12, and the teeth are milled to the square shape. A high quality of tool steel is used for these broaches and they are hardened, of course, and drawn to a medium straw color. It is only by using the utmost care and the best of steel that the broaches will last for any length of time upon this work. The pulling strain is so great that unless properly made they are quickly broken.

The broaching operation leaves the tool-holder in the condition shown at E in Fig. 2 except for drilling and tapping for the set-screw used for clamping the tool-bit.

When drilling the hole for the set-screw in the off-set tool-holders, the jig shown in Fig. 5 is employed. On this operation the jig is used in the horizontal position shown at the right, and the drill is inserted through bushing H. When drilling the left-hand off-set tool-holders it is used in the position shown, and when drilling the right-hand off-set tool-holders the bushing is reversed and reclamped by the set-screw shown at the side, the jig being tilted to the opposite horizontal position. Taken all together, there are six distinct

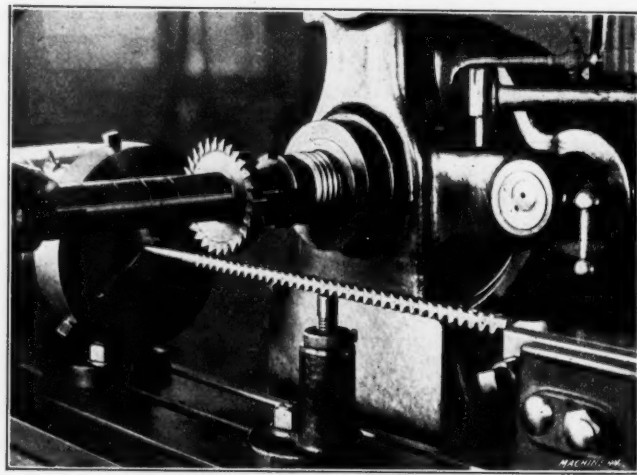


Fig. 12. How the Broaches are made

Locomotive Co. has produced a spark arrester especially designed for engines burning lignite, and this has been applied to twenty-one locomotives on the Chicago & Northwestern R. R. The Chicago, Burlington & Quincy R. R. has also developed an apparatus so that lignite may be burned without danger of sparks causing fires along the right of way. As the cost of a good grade of coal in the western sections of Nebraska, Wyoming and Colorado ranges between \$5 and \$6 per ton, it would be of great advantage to be able to use lignite from the mines in North Dakota, which could be bought at a price of \$1.75 per ton. The disadvantages of lignite are that in its raw state it must be used a very short time after it is mined, because if long exposed to the weather, it crumbles into small particles. As a means of overcoming this difficulty, briquetting has been resorted to successfully.

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Fire losses and the cost of fire prevention in the United States amounts annually to \$450,000,000, which is more than the total American production of gold, silver, copper and petroleum in a year.

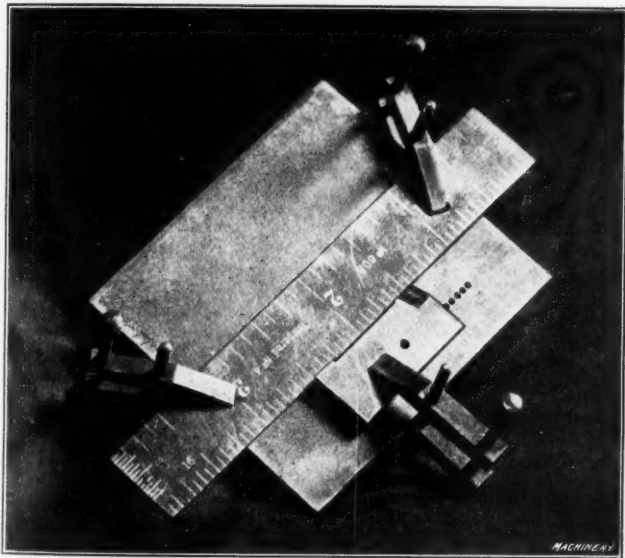
# LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

## TO DRILL SMALL HOLES IN ROWS AT EQUAL DISTANCES APART

No doubt the majority of machinists and toolmakers are well aware of the time required to lay out a row of small holes, say for a No. 60 drill, and drill the holes accurately. For example, take a row of holes 1/16 inch diameter and 1/8 inch pitch; the average machinist will scribe a center line, find his first center and proceed to lay out the other holes from it with dividers, scribing each circle off with dividers. Everyone knows how difficult it is to drill the small circles accurately, but I have seen machinists do this work in the ordinary way, and they were good men too; they did not realize that it was possible to save their time and eyes by a simple means.

We will take, for example, a row of holes 0.025 inch diameter, 1/16 inch pitch, which must be drilled with no variation exceeding 0.001 inch, the holes to be in a straight line, and another row of the same size and pitch, drilled on a line at an angle to the first row. The job can be accomplished simply and quickly as indicated in the illustration, which practically explains itself. The method is as follows: Lay out the first holes on each line and drill them. Then take a small piece of steel for a drill guide, bevel one corner and scribe a line on the bevel section as shown in the illustration. Line up the hole drilled in the guide with the hole drilled in



To Drill Small Holes in Rows at Equal Distances Apart

the work while the scale is clamped so that one of the sixteenth graduation marks matches the line on the drill guide, placing the scale with the edge exactly parallel to the center line of the row of holes to be drilled. Now proceed to drill the holes, setting the drill guide each time to the next sixteenth graduation and using a glass to accurately line the graduation mark with the line on the drill guide. If two or more rows of holes are to be drilled parallel, the drill guide block can be drilled to suit. The drill guide block should be relieved slightly in the center so as to insure the ends of the block bearing against the scale.

A toolmaker can drill a row of holes accurately in the manner described in the time required to lay them out in the usual way. Even if the holes do not require to be drilled so very accurately, it is quicker to drill them in this way than by the common method.

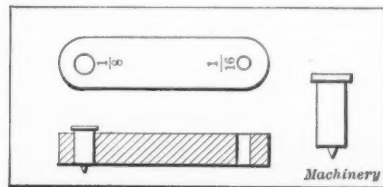
Philadelphia, Pa.

FRED HENKE

## METHOD OF ACCURATELY LOCATING DRILLED HOLES

The tool illustrated herewith affords one of the most accurate methods which the writer has seen for quickly locating and drilling work which has been laid out with a height gage

and center-punch. The illustration shows this tool full size for drilling holes 1/8 and 1/16 inch in diameter. It was made from a piece of 3/16 by 5/16 inch cold-rolled stock which was ground top and bottom and had the holes drilled and reamed slightly under size. The sizes of the holes were next stamped on the tool which was then hardened, after which the holes were lapped to the exact size. Two plugs—one of which is shown in place in the tool and the other separate on an enlarged scale—were made from drill rod. These plugs were first roughed out and partly cut from the rod; they were next hardened, ground and lapped on the body and point, and then broken off and ground on the top.



Device used for locating and drilling Holes

In using this tool the work is first laid out with a height gage or by some equivalent method according to the accuracy that is required. The centers for the holes are next punched, and the tool is placed on the work with the point of the plug in the center-punch mark and securely clamped to the work, after which the plug is removed. The work is then spot-drilled, drilled with a reamer size drill, and finally reamed with a special reamer, all of these operations being performed through the hole in the tool. The reamer used for this purpose must be a nice fit in the tool, and those used by the writer are made like a rose reamer except that they have only one flute and consequently but one cutting edge. If these tools are properly made, the degree of accuracy which can be obtained with them is in exact proportion to the degree of accuracy with which the work is laid out and center-punched.

The writer has found that the best method of laying out the work is as follows: After grinding the surface of the work to a good finish, the lines are laid out on this surface and then, to make the intersections more distinct, a fine oil-stone (instrument hone) is rubbed lightly over the lines. This operation is continued until the slight burr which is left by the scribing point has been removed. When lines prepared in this way are looked at through a magnifying glass the intersection of the lines will stand out sharp and clear without the usual "fuzzy" appearance. Instead of using the usual center-punch and hammer for centering, the writer has ground and stoned a small round file to a point. With the aid of a magnifying glass the point of this tool is placed on the intersection of two lines and a little pressure is then applied on the tool while it is twirled between the thumb and finger. A small center mark is made in this way and if a careful inspection shows it to be slightly off center, the error can be remedied by tipping the file slightly and repeating the operation. It will be found advisable to make this center mark as light as possible, as only a slight indentation is required to hold the point of the locating plug in place. This method insures locating a hole within  $0.0005 \pm$  inch, and for die work the writer knows of no better method of obtaining accurate results. It will be obvious that the tools can be made up in any size to meet the requirements of different classes of work.

DONALD BAKER

Beverly, Mass.

## LAPPING CALENDER ROLLS

The writer recently made a successful experiment in lapping a set of chilled calender rolls for a paper making machine. There were five rolls in this set, the working surface being 7 feet long, the diameter of the bottom roll 16 inches, and of the upper rolls 12 and 10 inches. These rolls become worn in the middle, in course of time, with the result that the paper is squeezed thinner at the outer edges than at the center; and this causes the reels of paper to run badly in subsequent

operations. When the rolls have worn 0.001 inch hollow they are considered to be in bad condition and have to be reground. The usual method is to grind them in a machine of the J. Morton Poole type, but as we have no such machine in this part of the world, we have to box up the rolls and send them 14,000 miles to get this work done.

It occurred to the writer that it might be worth while to try the effect of lapping, since there was not more than 0.001 inch to remove from any of the rolls. This method would not

In a stack of rolls such as this, it is the custom to make the bottom roll barrel shaped an amount which experience has shown to be necessary to cause it to be straight on top when under working pressure. The other rolls are made cylindrical. In this case we lapped the top roll first and made it as nearly cylindrical as possible, using a special sensitive caliper for making measurements. We next lapped the roll that worked with it, and after making it as nearly cylindrical as possible we placed the first roll in position on top of it with cigarette

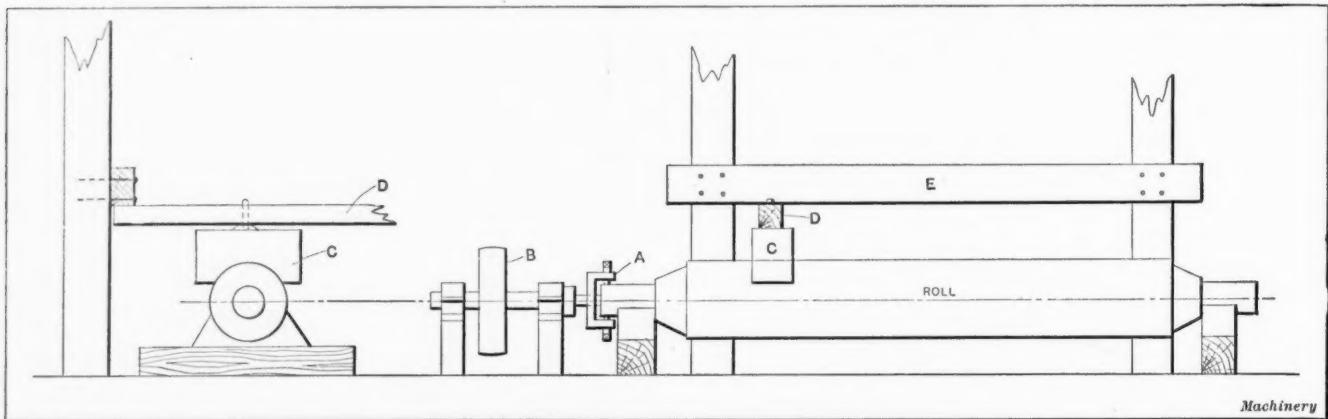


Fig. 1. Improved Equipment for lapping Calendar Rolls

be successful if the body had worn out of true with the journals, but as the rolls had been ground in the regular way several times, this was unlikely. An arrangement was rigged up as shown in Fig. 1, with the roll driven by a "wabbler" A, and although this was hardly necessary, it was found convenient. The pulley B carried a 6-inch belt and was driven from a countershaft with fast and loose pulleys. The lap C was made by casting a sheet of lead 9 inches wide, 3/8 inch thick,

papers between. When these papers were nipped evenly from end to end, we went on to the next roll. The required camber was then put on the bottom roll, as nearly as we could judge, using the line of light as a guide.

At first we ran the journals, which were five inches in diameter, in hardwood bearings, but as they heated considerably we afterward lined them with babbitt, and then they ran much cooler. The rolls were run at about a hundred revolutions per minute. The resulting set of rolls seems to have given as much satisfaction as if they had been ground in the orthodox way. We have also used the Roy portable grinder, made by B. S. Roy & Son, Worcester, Mass., for truing up the cotton rolls of a glazing calendar without taking them out of the frame. Fig. 2 shows the grinder in position for doing this work.

Christchurch, New Zealand.

JOHN PEDDIE

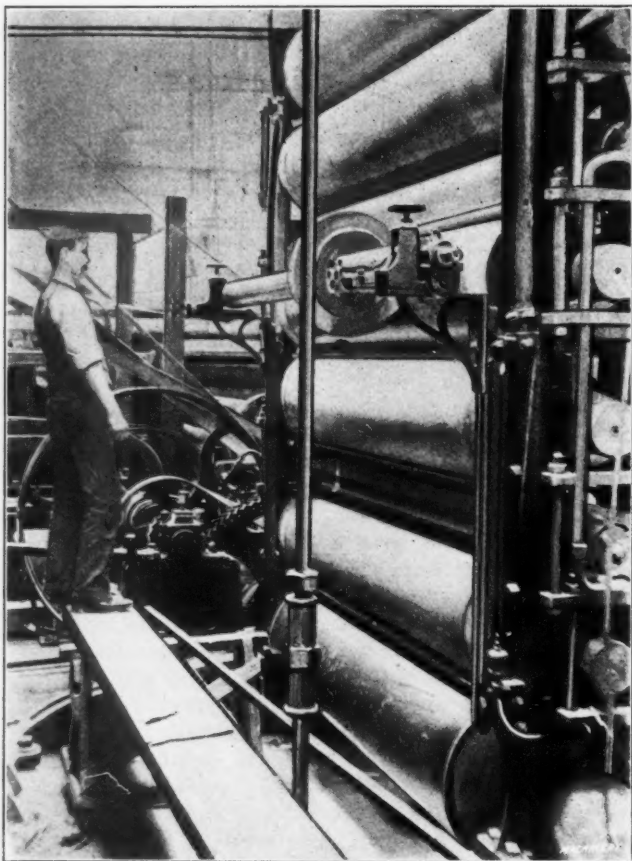


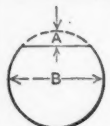
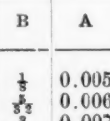
Fig. 2. Use of the Roy Portable Grinder on the Rolls of a Glazing Calendar

and long enough to embrace one-third of the circumference of the roll. This lead sheet was beaten carefully to make it fit the surface of the roll. A rough wooden box was then fitted around it and concrete filled in, an iron spindle being bedded in the top to hold the lever D that was used for moving it back and forth and for applying the necessary pressure. This lever was about 8 feet long, and the batten shown nailed to the posts was used to hold down the short end of the lever. Emery and oil sprinkled on the lap was used as the abrasive.

### TABLE OF DEPTHS OF CUT FOR FLATS ON SHANKS

In the December issue of MACHINERY a correspondent recommends the standardization of set-screw flats on round tool-shanks, making their width three-eighths the diameter of the shank. The writer would like to suggest that the man who

TABLE OF DEPTHS OF CUTS FOR FLATS ON SHANKS

		B	A	B	A	B	A	B	A
		$\frac{3}{8}$	0.010	$\frac{1}{2}$	0.027	$1\frac{7}{8}$	0.053	$2\frac{1}{8}$	0.078
		$\frac{1}{2}$	0.011	$\frac{3}{4}$	0.030	$1\frac{1}{2}$	0.055	$2\frac{3}{8}$	0.080
		$\frac{5}{8}$	0.013	$\frac{7}{8}$	0.032	$1\frac{3}{4}$	0.058	$2\frac{1}{2}$	0.082
		$\frac{3}{4}$	0.014	$1$	0.034	$1\frac{5}{8}$	0.060	$2\frac{5}{8}$	0.084
		$\frac{7}{8}$	0.015	$1\frac{1}{8}$	0.037	$1\frac{1}{2}$	0.062	$2\frac{3}{4}$	0.087
		$1$	0.016	$1\frac{1}{4}$	0.039	$1\frac{3}{4}$	0.064	$2\frac{7}{8}$	0.089
		$1\frac{1}{8}$	0.017	$1\frac{3}{8}$	0.042	$1\frac{7}{8}$	0.067	$2\frac{1}{2}$	0.091
		$1\frac{1}{4}$	0.018	$1\frac{7}{8}$	0.044	$1\frac{5}{8}$	0.069	$2\frac{3}{4}$	0.096
		$1\frac{3}{8}$	0.021	$2$	0.046	$1\frac{1}{2}$	0.071	$2\frac{5}{8}$	0.100
B	A	$1\frac{7}{8}$	0.023	$2\frac{1}{8}$	0.048	$2\frac{3}{8}$	0.073	$2\frac{7}{8}$	0.105
		0.025	$2\frac{3}{8}$	0.051	$2\frac{7}{8}$	0.075	$3$	0.110	

mills this flat needs the dimension A—the depth of cut—and that a depth of 0.0365 B will give the desired width of flat, where B is the diameter of the shank. The table gives the depth A for the sizes enumerated in the contribution published in the December issue.

New London, N. H.

GUY H. GARDNER

### ERASING INK FROM TRACINGS

In a large tracing department it is often necessary to do wholesale erasing. This is not only due to errors but also to

changes that have to be made in tracings after they are done. To properly remove this ink requires careful work and some time, if the work is done by hand. This is due to the necessity for pressing lightly on the cloth to prevent tearing. In such cases a power-driven eraser is of considerable value, and one can be made from a fan motor and a piece of flexible shaft with a screw and nut to clamp the circular eraser to the shaft. By pressing very lightly, the high speed of the eraser removes the ink without loss of time.

F. W. H.

### ETCHING FLUID FOR STEEL

Some years ago, a formula for etching fluid for steel was published in *MACHINERY*, by Mr. W. S. Leonard. This called for nitric acid, 60 parts; water, 120 parts; alcohol, 200 parts; and copper nitrate 8 parts. The writer tried this fluid, but did not have success with it. After some experimenting, however, he found that by using 8 parts of the mixture made according to Mr. Leonard's formula and adding 1 part of muriatic acid, a very satisfactory etching fluid can be obtained. After having poured the muriatic acid into the other solution, the bottle must be left uncorked for about fifteen minutes to allow the gases produced to escape and prevent an explosion.

New Britain, Conn.

W. C. BETZ

### PIVOT BEARINGS IN TYPEWRITER WORK

One of the most important items in typewriter manufacture is the producing of an accurate pivot bearing. The most successful way of doing this is to swage the soft bearing to the form of a hardened pivot. The bearings are first counter-

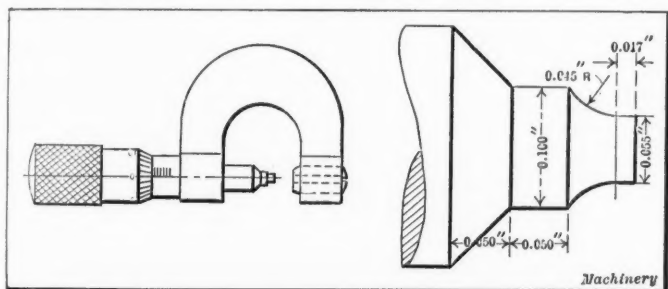


Fig. 1. Special Gage for measuring Pivot Bearings

sunk as closely as possible to the finished form. An excellent device for gaging them after this operation is shown in Fig. 1. This gage is made from a micrometer of the 1/2-inch size, the end of the spindle being ground to the shape

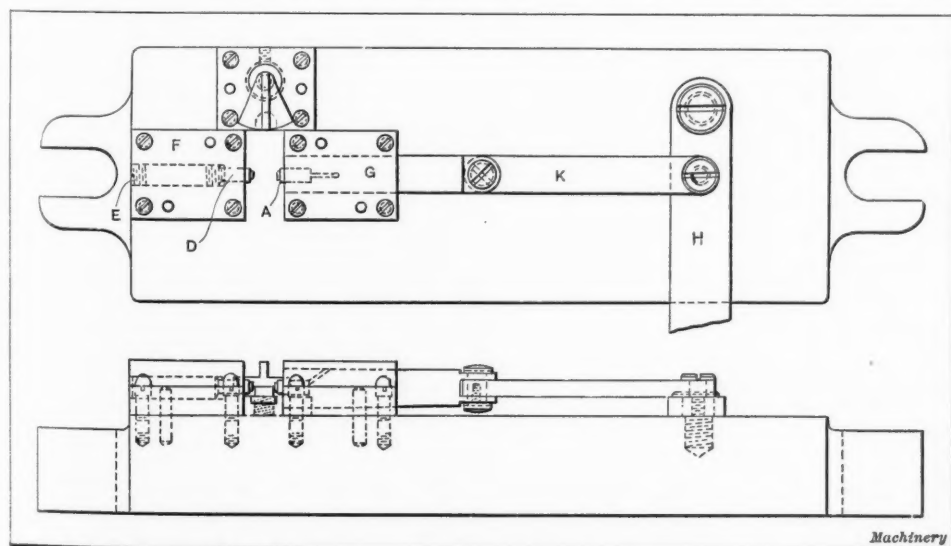


Fig. 2. Swaging Fixture for forming Pivot Bearings

of the pivot; this allows the depth of the bearing to be gaged to 0.001 inch, or if necessary, to 0.0001 inch. After the bearing or pivot holder has been countersunk, the hardened pivot is placed in it and the bearing is swaged to the form of the pivot by the fixture shown in Fig. 2.

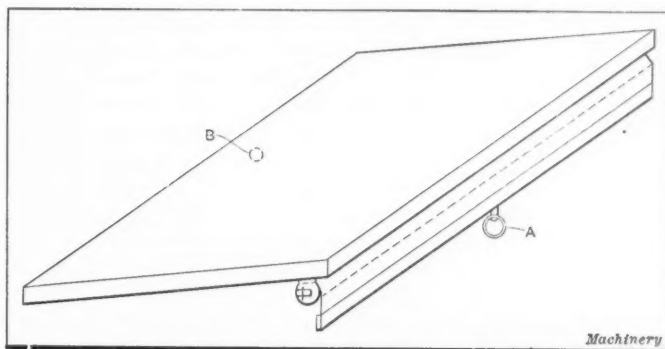
The anvils for the swaging operation are shown at A and

D. The ends must be cup-shaped, although this is not shown in the engraving. The stationary anvil D is carried in block F and adjusted by screw E. The other anvil is held in plunger G, operated by handle H by means of connecting-rod K. The bearing is not formed by pressure, but by the striking of a quick steady blow.

A. GRAY

### DRAWING BOARD DUST CURTAIN

In the following article is described a little kink for keeping dust and dirt from settling on a drawing-board during the night or whenever the draftsman leaves it for any length of time. It is simply a window shade roller of about the right length to suit the drawing-board. The roller is attached to the under side of the board by the usual form of brackets,



Curtain for keeping Dust off a Drawing-board when not in use

and has a wire across the open bracket to keep the roller in place, as shown in the illustration. Whenever the draftsman has occasion to leave his board for any length of time he simply reaches over and takes hold of the small ring A and pulls the curtain up over the board so that the ring can be secured by a screw B on the under side of the board near the front edge. This completely covers the drawing, so that it is protected from dust and dirt. The writer has used this attachment for over a year and has found it to be well worth the trouble which was taken in setting it up. As he has never seen a similar device he thought it might be of interest to other draftsmen.

A. H. WILSON

Chicago, Ill.

### ECONOMICAL DRAFTING-ROOM PRACTICE

There is a chance for a lot of lost motion to occur in the average drafting-room due to the use of methods which are too conventional. The average draftsman likes to do a good job

and he will do one if left to himself, but he should be watched to see that he does not do too good a job. The principal fault to be found in most drafting-rooms is that pencil drawings are made with too much care, because they are simply used to make tracings. There is no reason why the draftsman should take pains with the lettering, cross-sectioning and general appearance of a drawing. The cross-sectioning should be put in free-hand, and the tracer ought to know enough to put on the "pretty work." This is one of the places where the principle of "good enough" applies. It is the practice of many drafting-rooms to make pencil drawings and tracings where the parts could just as well be drawn directly on the tracing cloth or on a good grade of bond

paper at a considerably reduced cost.

Whenever the writer sees a fine drawing out in the shop he thinks of an anecdote told by old man McGuinness who owns a big cement mill out in California. One of his men took McGuinness up to a rival mill and showed him a very fine switchboard which had been installed in the power plant. The

old man seemed interested and was told about the uses of the board. At his mill things were rather primitive, and it was hoped that he would show some spirit of emulation after seeing the fine outfit in his competitor's plant. When he turned away from the marble and polished brass front of the big switchboard the man who was showing him around asked him what he thought of it. The old man grunted. "Huh," said he, "that thing don't make no cement." The same sort of comment would apply to the practice followed in many drawing-rooms; there is a lot of work done which does not produce results.

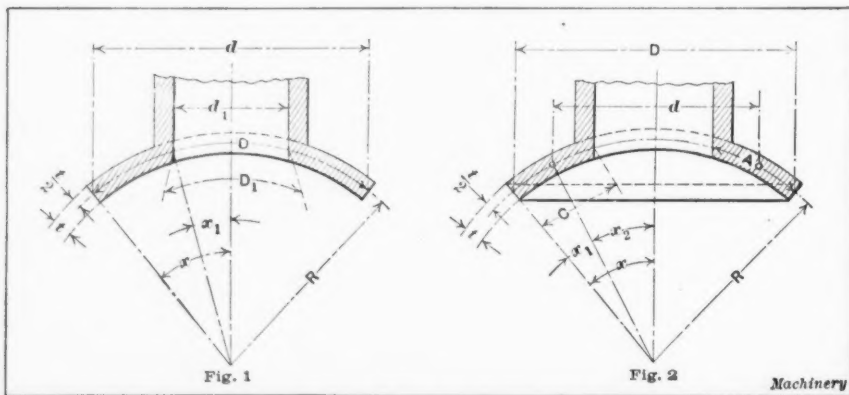
Los Angeles, Cal.

F. W. HARRIS

### HOW TO FIGURE THE VOLUME OF CURVED FLANGES

In figuring the volume of large curved flanges, to get the weight, the following methods will give good results:

The developed surface of the curved flange shown in Fig. 1 would be an ellipse with an elliptical hole.  $D$  and  $d$  are the large and small outside diameters, respectively, and  $D_1$  and  $d_1$



Figs. 1 and 2. Two Types of Curved Flanges showing Method of figuring their Volumes  
the large and small inside diameters. We first find the angles  $x$  and  $x_1$ , by

$$\sin x = \frac{d}{2R}$$

$$\sin x_1 = \frac{d_1}{2R}$$

$$D = \frac{2x}{360} \times 2\pi R = 0.0349Rx.$$

Then the area of the flange, if it were solid, would be  $0.7854dD = 0.7854d \times 0.0349Rx = 0.0274dRx$ . Similarly,  $D_1 = 0.0349Rx_1$ , and the area of the hole  $= 0.0274d_1Rx_1$ . Then the

The area of the cross-section of the flange is  $At = 0.0349Rtx_1$ .  $d$  is the diameter of the circle that passes through the center of gravity of all right sections of the flange. This center of gravity is taken at the point which bisects the arc  $A$ . Although this is not strictly correct, the difference would be so small that it may be neglected.

$$d = 2R \sin x_2.$$

The circumference of this circle  $= 6.2832R \sin x_2$ .  
Then the volume of the flange  $= 6.2832R \sin x_2 \times 0.0349Rtx_1 = 0.2193R^2tx_1 \sin x_2$ .

McKees Rocks, Pa.

AUGUST H. ANGER

### A SIMPLE RULE FOR ESTIMATING TENSILE STRENGTH

The following gives a simple rule for estimating the tensile strength of steel forgings. A strength of 40,000 pounds per square inch, which is about the tensile strength of ordinary iron, is used as a basis, and an additional 1000 pounds per square inch is added for each point of carbon in steel. For instance, the tensile strength of a 20-point carbon steel would be 40,000 plus 20,000 equals 60,000 pounds per square inch. Similarly a 60-point carbon steel would have a tensile strength of 40,000 plus 60,000 equals 100,000 pounds per square inch. While this method of estimating tensile strength is not absolutely exact, it is near enough for ordinary purposes where open-hearth steel forgings or bars of open-hearth steel are being dealt with.

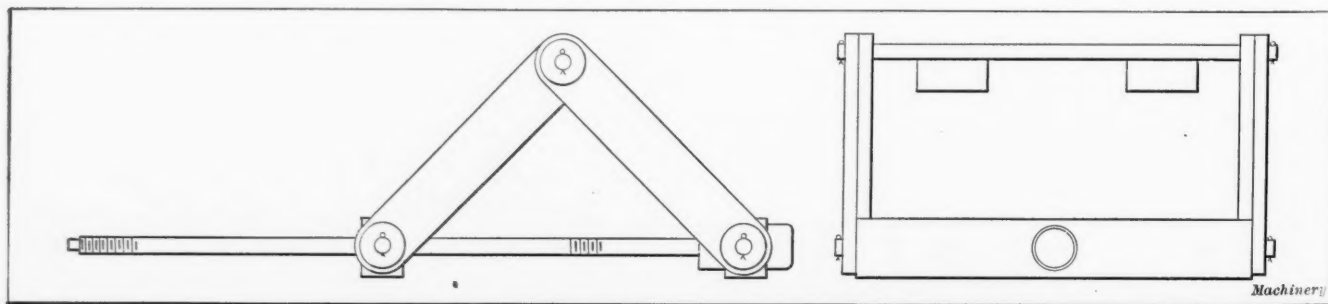
Cleveland, Ohio.

R. L. TAPPENDEN

### A USEFUL JACK-SCREW

The illustration shows a jack-screw which has been used by the writer for over ten years for lowering grindstones weighing from 2500 to 4000 pounds into their bearings, and to raise stones which have become cracked or loose on the shaft. Existing conditions made it impossible to use hoisting apparatus for this purpose and the old method was to roll the grindstone up an inclined plank until the shaft was over the bearings. Boards were next placed over the bearings and the block knocked out from under the end of the inclined plank. A lever was then used to raise the shaft, first at one and then at the other, to allow the boards to be removed from the bearing and the shaft to be lowered into place. This method was obviously crude and very hard on the babbitt bearings.

The jack shown in the accompanying illustration was designed to take the place of this method. When down, this jack is only 3 inches high and it can be used to raise a weight to



Jack-screw with Range of Three Times its Height when Closed

exact volume of the flange  $= (0.0274dRx - 0.0274d_1Rx_1)t = 0.0274Rt(dx - d_1x_1)$ .

The spherical flange as shown in Fig. 2 may be figured as follows: First we find the angles  $x$  and  $x_1$ , by

$$\sin x = \frac{D}{2R}$$

$$\sin x_1 = \frac{C}{2R}$$

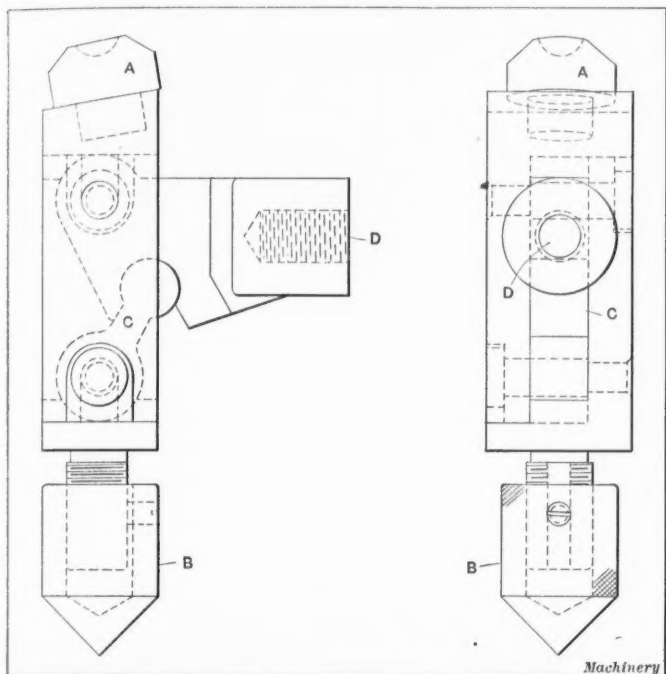
$$A = \frac{2x_1}{360} \times 2\pi R = 0.0349Rx_1.$$

a height of 9 inches, or more than three times the height of the jack. The design will be readily understood from the illustration, in which connection it may be mentioned that the screw has an Acme thread. Although this jack was designed for the particular class of service referred to, it would be equally suitable for a variety of other purposes. E. H. C.

[This form of jack is, no doubt, an effective means for lowering weights where the clearance is small, but it can hardly be efficient for lifting purposes when starting from the lowest position, because of the toggle action which multiplies the pressure on the screw and consequently the frictional resistance.—EDITOR.]

## TOGGLE-JOINT HOLDER-ON FOR 12-INCH CHANNELS AND I-BEAMS

In the January issue of MACHINERY the writer had an article on a toggle-joint holder-on for use in riveting structural steel. This holder-on proved very satisfactory for all classes of service which did not require the tool to be used in close quarters. In trying to get up into a corner, however, it was found that the nuts on the sides of the tool made it impossible to get into such locations. To avoid this difficulty the tool shown in the accompanying illustration was designed. It consists of



Improved Type of Holder-on for working in Close Quarters

the two holders A and B that are forced against the work by means of the toggle-joint C which is actuated by a lever arm screwed in at D. In this tool the toggle-joint is located within the tool body, instead of being on the outside, and is secured in place by rivets instead of bolts and nuts. The present construction is quite strong enough for all practical purposes and is much more compact than the design illustrated in the January number of MACHINERY. The tool is used in the manner described in the previous article.

M. W. W.

## MAKING UNIFORM CAMS

The method of cutting cams having a uniform rise-and-fall is a very simple operation, when once the principles are well understood. The first point to be determined is the required

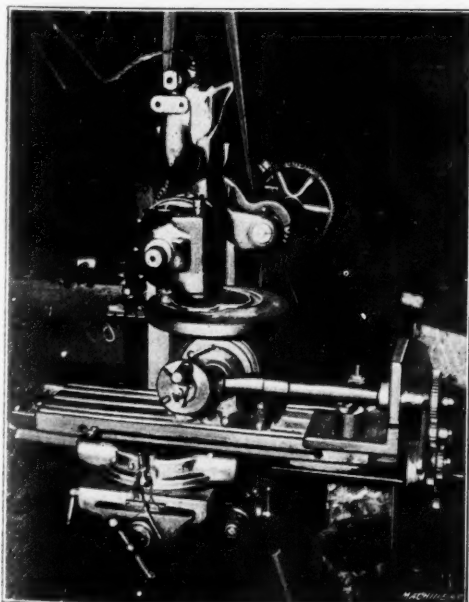


Fig. 1. Method of cutting Uniform Rise-and-fall Cams on the Milling Machine

amount of rise which you wish to impart to the follower. When this amount of rise has been determined, the spiral head of the milling machine should be geared to produce a lead of double the required rise, i. e., with a rise of 6 inches the head should be geared for a 12-inch lead. The rise of the cam will take up 6 inches of this lead, and the uniform fall a like amount.

As shown in illustration, the index head of the milling machine should be located at the center of the platen. This makes it necessary to use the gear extension shown, which is simply a keyed shaft having its bearing in the angle plate. The starting point of the rise of the cam is now determined and a hole of the proper size for the cutter should next be drilled; this hole may afterward be plugged up, if necessary. The hole should be brought to a position where a line dividing the cam movement into equal parts would be in a direct line with the feed-screw. The work may now be brought up to the cutter. The writer has found it advisable

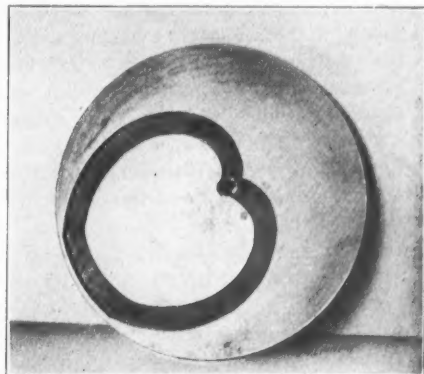


Fig. 2. Cam for producing Uniform Rise-and-fall with a Rest between the Rise-and-fall

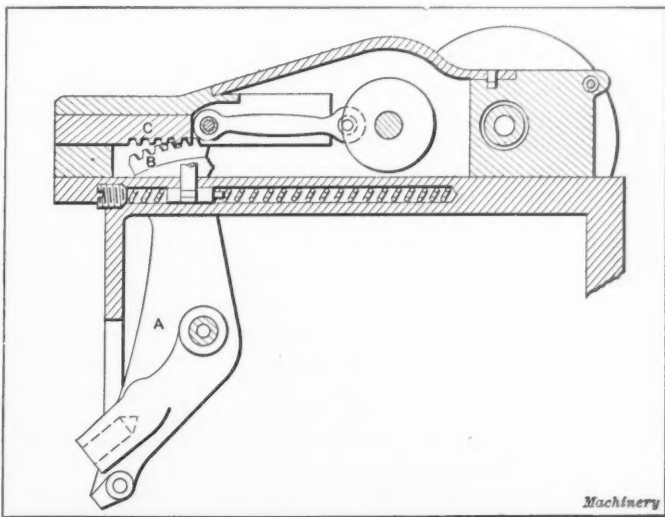
to cut the slot in one cut, especially if the machine used is an old one. The work is fed carefully until the maximum position is reached; the machine is then stopped, the gears reversed, and the cutter brought back to the starting point; the other half of the cam is then finished in the same way. A concentric arc, or "rest," may be milled at any desired point in the cam by simply stopping the feed, and indexing through the required number of divisions.

West Lafayette, Ind.

W. H. ADDIS

## TAKING OUT THE BACK-SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

In the February issue of MACHINERY, Mr. J. Harmon criticises an article published in the November issue of MACHINERY, dealing with the subject of "Taking Out the Back-shaft of a B. & S. Automatic," and requests Mr. Bacon to admit that in case a back-shaft is not replaced with each gear in the position which it formerly occupied, tooth for tooth, the machine will not be in operating condition because no matter to what extent an operator may change his job on the machine, all of the clutches, gearing, etc., will refuse to do their



Mechanism of Turret Slide of a B. & S. Automatic Screw Machine

work. Mr. Harmon then asserts that all operators will agree with him, but the writer is engaged in operating a Brown & Sharpe automatic screw machine and knows a few others who will not agree with Mr. Harmon because the dogs which govern the feeding of the stock, revolving of the turret and reversing of the spindle may be set in any position around the circumference of their carriers. The writer cannot speak for Mr. Bacon, but will say that he has operated B. & S. automatic screw machines with the back-shaft slightly misplaced in order to complete a "hurry up job" or until it was again convenient to remove the back-shaft and replace it correctly.

What, then, really are the conditions when a back-shaft is

not replaced with the gears meshed tooth for tooth? The error is usually one, two or three teeth and the result is that the turret-revolving crank will not be on a dead center, as shown in the accompanying illustration. Consequently, the distance between the spindle and the turret is lengthened and the job will have to be set out further from the spindle, which will necessitate resetting the turret-revolving dogs. The error resulting from a slight misplacement of the gear which rotates the cam-shaft for feeding the stock may be corrected sufficiently by resetting the tripping dogs but, of course, such a condition should not be allowed to exist except in cases of emergency. The writer has also used the method described by Mr. Harmon for machining long parts, and has noticed the binding of the rack as mentioned in the editor's note. The stop which is used for stopping the return of the turret and carriage was removed, and washers were inserted underneath for replacing it, but this method should only be used temporarily.

ELAM WHITNEY

[Those who have had wide experience in the operation of the Brown & Sharpe automatic screw machine find that it is not required to take out the back-shaft more frequently than once a year—except in cases of accident—and even then it would not, as a rule, be necessary. Instances are on record where machines of this type have run for four or five years without requiring the removal of the back-shaft, but this naturally depends upon the character of the work being done by the machine. The removal of the back-shaft for cleaning is dependent to a large extent on the grade of cutting oil or compound which is used.—EDITOR.]

### COMBINATION PUNCHING, CUTTING AND FORMING DIE

The illustrations show a combination punching, cutting and forming sub-press die that produces cleats from No. 24 galvanized iron at one stroke of the press. These cleats, one of which is shown in Fig. 1, are used for the reinforcement of metal window frames. Fig. 1 also shows the front view of the punch and die, with the punch in the lowest position, and a separate view of the cutting and forming tool *E*. Fig. 2 shows a plan view of the die and Fig. 3 a cross-section of the punch and die in position for the piercing operation. The machine used in this particular case was a Loy & Nawrath No. 2 press, running at 125 R. P. M. The punch- and die-holders are made of cast iron; the punch-holder *A* is provided with a shank which fits into the press slide, and the base *B* is fastened to the press bolster by two screws. Two guide-pins *C* are used to provide for accurate working, permanent and perfect alignment, and a rapid means of setting the die. The punch-holder carries the punches *D* and *D*<sub>1</sub>, which are of  $\frac{3}{8}$  and  $\frac{3}{16}$  inch diameter, respectively, and the cutting and bending tool *E*, shown separately in Fig. 1. The die-holder *B* has the punch-plate *F* fastened to it, as shown in Fig. 3; this punch-plate has a cutting edge *G*, Fig. 2. A spring pad *H*, which forms the cleat, slides in back of the punch-plate; two dowel-

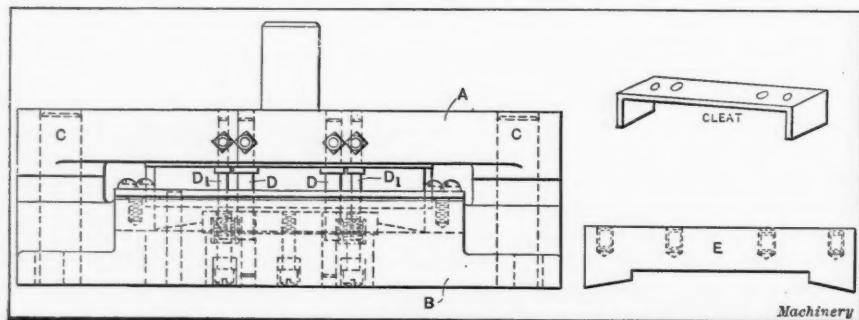


Fig. 1. Punch and Die with Punch in Lowest Position; also Finished Cleat and Cutting and Forming Tool *E*

pins *I* hold it in line and two springs *J* support it. A fixed stripper-plate *K* and two gages *L* hold the work in position.

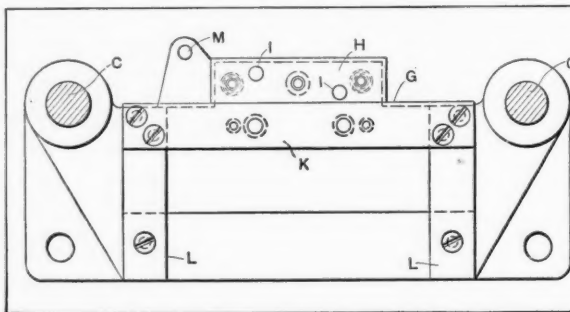


Fig. 2. Plan View of Punching, Cutting and Forming Die

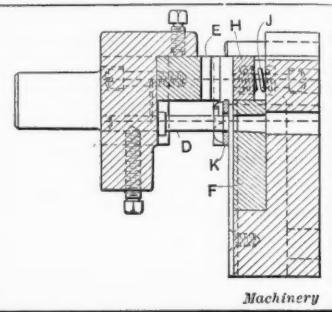


Fig. 3. Cross-section of Punch and Die

The operation is as follows: The material is cut in long strips of the proper width to fit between the gages *L*, a squaring shear being used for this purpose. One of these pieces is then placed under the stripper *K* so that a small portion will stick through at the cutting edge *G*. The punch, in descending, pierces the material and also trims the end square. The strip, thus squared and punched, is next pushed against the stop-pin *M*. The second stroke punches the four holes in the next piece; at the same time, the previously punched part is cut off and bent to the required form by the combination cutting and bending tool *E*. A finished cleat is thus

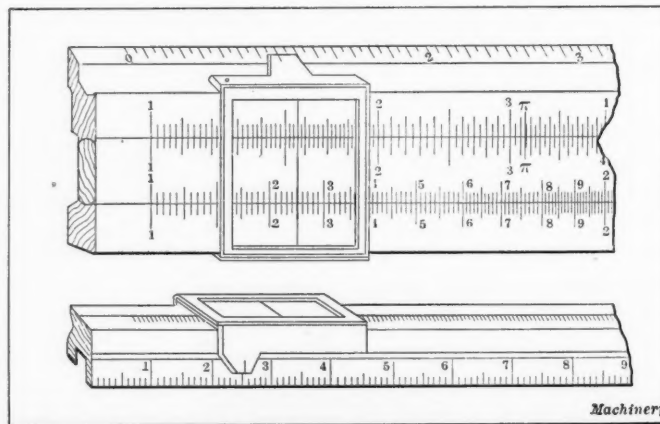
produced at each stroke of the press. The spring-pad *H*, which is the female bending member in this case, supports the cleat while it is being separated from the strip of stock and as soon as the spring pad comes into contact with the extending lug of the base *B*, the two edges of the cleat are drawn down. The finished cleat is pushed through the back of the press when the stock is advanced for the next operation. This die works very efficiently as it combines the three single press operations of cutting, bending and piercing, and also saves the time that would be required to transfer the blanks from one press to another, if the operations were performed singly.

Irvington, N. J.

F. SPARKUHL

### ANOTHER USEFUL SLIDE-RULE CONSTANT

The writer read an article in the November, 1912, issue of *MACHINERY* by A. Laurens entitled "Slide-Rule Constants."



Slide-rule Constant for converting Inches to Millimeters or Millimeters to Inches

The following describes and illustrates another useful constant for the regular slide-rule. An extension on the runner projects down on each side of the rule with an etched line marked on it. This line projects down onto the scale of inches on the front of the rule and onto the scale of millimeters on the back of the rule, and by setting the runner to any desired position, the equivalent of any number of inches may be read off on the millimeter scale; conversely, millimeters may be converted to inches without the necessity of using the regular conversion factors. The writer has found this to be a very useful addition to his slide-rule and hopes that it may be of service to other readers of *MACHINERY*.

Poughkeepsie, N. Y.

H. A. DUNCAN

# THE DESIGN OF CLUTCH RELEASE SHOES

The writer was much interested by Mr. Terry's article on the design of clutch shoes appearing in the January issue of MACHINERY, and fully agrees with his deductions. It is the object of the present article to give in a single equation the equivalent of Mr. Terry's method, but presented in a simpler form; an approximate graphical method will then be given, which should appeal to those designers who are not mathematically inclined. Referring to Fig. 1, let:

- $A$  = area of complete circle  $LMNV$ ;
  - $M_a$  = moment of this area about line  $o-o$ ;
  - $B$  = area of semicircle  $FGH$ ;
  - $M_b$  = moment of this area about line  $o-o$ ;
  - $C$  = area of rectangle  $EFHI$ ;
  - $M_c$  = moment of this area about line  $o-o$ ;
  - $D$  = area of circular segment  $LVN$ ;
  - $M_d$  = moment of this area about line  $o-o$ ;
  - $S$  = area of shoe, i. e., of figure  $LMNIGEL$ ;
  - $M_s$  = moment of this area about line  $o-o$ ;
  - $z$  = distance from line  $o-o$  to center of gravity of area  $S$ .
- $R, r, f, x$  and  $\beta_o$  are given in Fig. 1.

The following equations can now be written:

$$\begin{aligned} A &= \pi R^2 & (1) & & M_a &= 0 & (2) \\ B &= \frac{\pi r^2}{2} & (3) & & M_b &= \frac{2}{3} r^3 & (4) \\ C &= 2rf & (5) & & M_c &= rf^2 & (6) \\ D &= \frac{\pi R^2 \beta_o}{360} - fx & (7) & & M_d &= \frac{2}{3} x^3 & (8) \end{aligned}$$

Then

$$S = A - B - C - D = \pi R^2 - \frac{\pi r^2}{2} - 2rf - \frac{\pi R^2 \beta_o}{360} + fx$$

$$S = \pi R^2 \left(1 - \frac{\beta_o}{360}\right) - \frac{\pi r^2}{2} + f(x - 2r) \quad (9)$$

$$M_s = M_a + M_b - M_c - M_d$$

$$M_s = M_a - M_b + M_c + M_d = -\frac{2}{3} r^3 + rf^2 + \frac{2}{3} x^3 = \frac{2}{3}$$

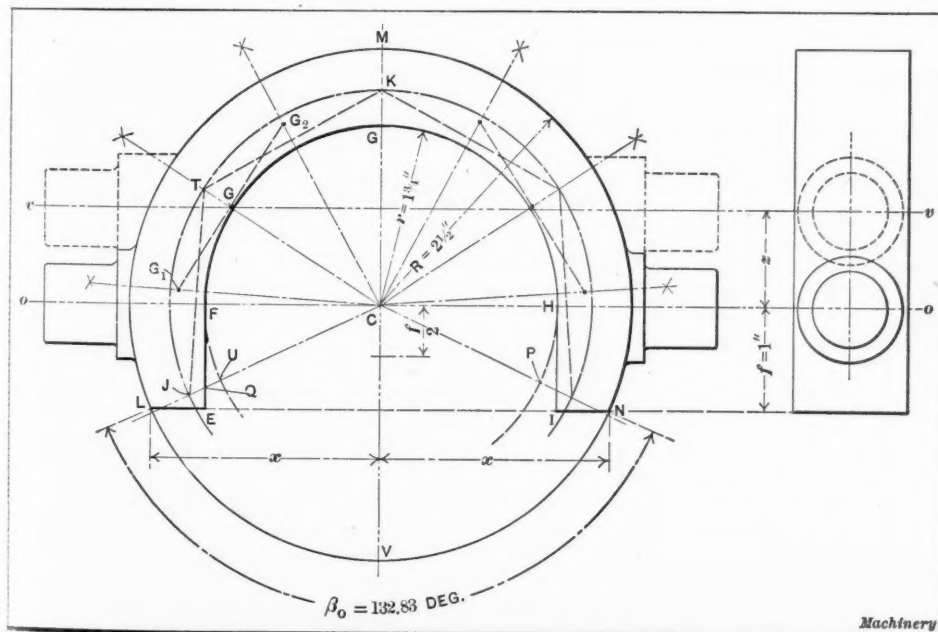


Fig. 1. Diagram used in locating the Center of Gravity of the Clutch Release Shoe by Analytical and Graphical Methods

$$(x^3 - r^3) + rf^2 \quad (10)$$

$$z = \frac{M_s}{S} = \frac{\frac{2}{3} (x^3 - r^3) + rf^2}{\pi R^2 \left(1 - \frac{\beta_o}{360}\right) - \frac{\pi r^2}{2} + f(x - 2r)} \quad (11)$$

Equation (11) looks rather formidable but as  $\pi R^2$  is the area of a circle whose radius is  $R$ , and  $\frac{\pi r^2}{2}$  half the area of a circle whose radius is  $r$ , these values may be taken directly

from a table, while the values of  $x^3, r^3$  and  $f^2$  may be taken from a table of squares and cubes. In the example given,

$R = 2.5$  inches,  $r = 1.75$  inch,  $f = 1$  inch.

$x = \sqrt{R^2 - f^2} = 2.291$  inches,  $\beta_o = 132.83$  degrees.

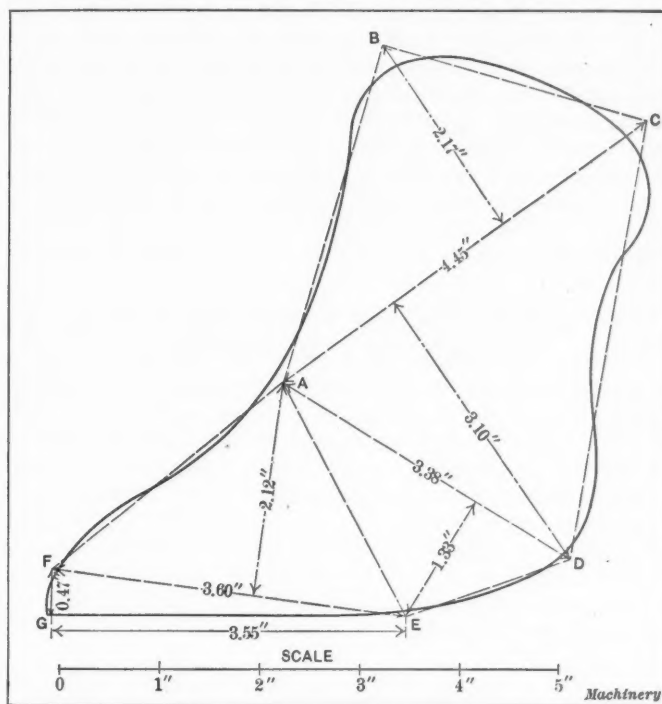


Fig. 2. Example of the Accuracy that can be obtained by Careful Approximation

Substituting these values in Equation (11) and solving,  $z = 0.972$  inch.

Mr. Terry's result was  $z = 0.978$  inch.

An approximate method, sufficiently accurate for all practical purposes, is as follows: Draw  $CJ$  so that, judging by the eye, the area of triangle  $EQL$  is approximately equal to or slightly less than the area of  $FQU$ . Draw arc  $JK$  with a mean radius, bisect this arc and draw  $CT$ . Next bisect arcs  $TJ$  and  $TK$ , and then draw the chords  $TJ$  and  $TK$ . Locate the points  $G_1$  and  $G_2$  so that they appear to be slightly nearer to the arc than to the chord. Connect  $G_1$  and  $G_2$  by a straight line cutting  $CT$  at  $G$  and draw line  $v-v$  through  $G$  parallel to  $o-o$ . The line  $v-v$  passes approximately through the center of gravity of the figure  $ULMNPUGU$ , and the center of gravity of this figure is approximately coincident with that of the wearing face of the shoe  $ELM NIG$ ; therefore, the proper location of the pins for equal distribution of wear has been located. Fig. 1 was drawn full size and the dimension  $z$  scaled  $15/16$  inch, a result about  $1/32$  inch less than that calculated by Equation (11).

To the precise, this method may seem little better than a crude guess, but the designer's eyes are educated to such approximations. Another example of a somewhat similar nature involving judgment of the eye is illustrated in Fig. 2. Here it is required to find the area of the irregular figure

bounded by the curved line. The figure is first divided into triangles approximately equaling the area of the figure. The altitude and base of each triangle, as scaled, are given in the figure, the resulting area being 18.62 square inches. Going over the figure with three planimeters gave results as follows:

No. 1. One trial only.....	18.7 square inches
No. 2. First time around read.....	18.3 square inches
No. 2. Second time around (36.5 ÷ 2).....	18.25 square inches
No. 3. First trial.....	18.45 square inches
No. 3. Second trial.....	18.50 square inches
Average of three planimeters.....	18.44 square inches

Taking this average as correct, the error is:

$$100 [(18.62 - 18.44) \div 18.44] = 0.98 \text{ per cent.}$$

If we take the reading of 18.25 square inches as correct, which was the result obtained with the most modern instrument, the error is

$$100 [(18.62 - 18.25) \div 18.25] = 2.03 \text{ per cent.}$$

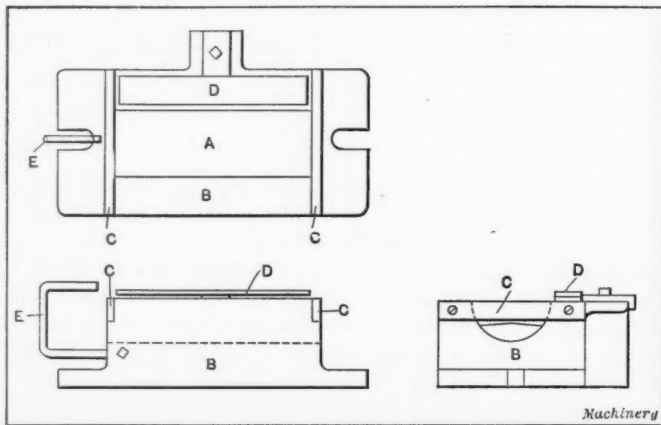
There are many approximate methods applied in the drafting-room which depend largely upon the eye-judgment of the designer and yet, in their final results, such methods are all that could be desired. In fact, it is generally the chief's "eye-judgment" which approves or disapproves the finished design, for he has learned that when a thing looks wrong there generally is a "bug" in it somewhere.

Philadelphia, Pa.

JOHN S. MYERS

### SELF-ALIGNING FIXTURE FOR A STAMPING MACHINE

In the shop where the writer is employed a variety of steel and cast-iron work is marked with the company's name, the date on which the patent was granted, etc. This marking is done on a roll stamping machine of the type which was illustrated and described in the January, 1912 issue of MACHINERY. Continued service results in the arbor and bearings of this machine becoming worn and after trouble of this sort is once encountered, it is only a short time after adjustment is made before the machine will again be out of alignment. The result of this wear is that the impression made by the stamp



Fixture for adjusting Alignment of Work in a Stamping Machine

will be heavier at one side than it is at the other, or in the language of the press-room, it is "running light" on one side. To remedy this fault, the light side of the work was raised by placing a strip of paper under it, and by this means fairly satisfactory results were obtained before the bearings had become sufficiently worn to make adjustment absolutely necessary. As many as six sheets of paper would sometimes be used for this purpose, and the amount of time spent in "papering up" would frequently have paid for the cost of renewing the bearings.

As this method of securing alignment by use of sheets of paper was not satisfactory, it was decided to design a fixture which would automatically adjust itself to take care of any error of alignment in the arbor or its bearings. At the same time, it was desired to have this attachment of such a nature that it would be equally serviceable when the arbor alignment was perfectly accurate. The fixture designed for this purpose is illustrated herewith and will be seen to consist of the swivel bed device which is mounted on the regular work table of the machine. The base of the fixture consists of a cast-iron piece B which is planed on the bottom and bored out on the upper face to receive the turned steel piece A, which is planed off so that when in position its flat face is in the same plane as the upper surface of the piece B. The bearing surface between the pieces A and B is scraped to an accurate fit and kept carefully lubricated so that there is very little friction. In order to keep A in the required longitudinal position, and to prevent it from rotating too far, the stops C are screwed to the ends of the piece B. The ends of A extend under these stops and are milled off at an angle—as shown in the illustration—so that the piece A has just the required play in either direction

from the center line. One-sixty-fourth inch movement in either direction is provided for by this means.

It will also be seen that an adjustable gage D is provided which may be set for different widths of work and that an end stop E provides for locating the work longitudinally. The gage D is set slightly above the bed so that it will not interfere with the rotation of A. In setting up the machine for any particular job, the gage D is set so that the work is approximately under the center of the marking roll. Then if the bearings are worn so that any error up to 0.005 inch exists, the work levels itself automatically under the pressure of the stamping roll without any effort on the part of the operator. The base B is bolted to the machine and is also centered under the roll.

Middletown, N. Y.

DONALD A. HAMPSON

### HINTS FOR DRAFTSMEN

From time to time a number of rules for use in the drafting-room have been published in the columns of MACHINERY, but the writer has found the following to be a particularly satisfactory method of procedure for general routine work.

When designing a machine or part of a machine, the first step is to endeavor to see it clearly in your "mind's eye" before starting work; next make a few rough pencil sketches on scratch paper showing a general outline. An accurate assembly drawing can now be made and a list of the different parts that will be detailed is then made up from this assembly drawing. If it is found that the design of any detail will change any other part or parts of the machine, a list of such parts should be made. This work will occupy but a very short time and affords a safeguard against overlooking any part or change. When using such a system it will always be possible for the draftsman to give an immediate answer to questions regarding changes in design which have been made and the date when such changes become effective.

In checking up a design, the writer has found it useful to use a standard set of "test questions," which are given below:

Are all press fits on the right part to be most easily machined?

Do all parts correspond with the assembly?

Are the sizes of taps correct and are right- and left-hand threads provided in the proper places?

Are the over-all dimensions correct?

Are the ribs too heavy or too light, or are they just right?

Will each casting be as light as possible without being under undue strain?

What parts can be best produced by casting and what parts are most suitably produced by some other method?

Are all screws properly detailed?

Can all parts be easily assembled?

Has the list of commercial parts been made out?

Is the name, material and pattern number correct for each piece?

Is the title of each sheet correct?

Have any finish marks been omitted?

Have any arrow heads been omitted?

In preparing drawings enough views should always be shown to make the design readily understood by men in the shop. When it is necessary to make erasures on tracings, it will be found advisable to first use a knife to scrape the heavy coating of ink off, then use an ink eraser to remove the bulk of the line and a pencil eraser for the final part of the work. This method of erasing saves time and leaves a smooth finish on the tracing, so that it is unnecessary to use soapstone, and the tracing will not collect dust and dirt at the point where the erasure was made.

Springfield, Ohio.

HAROLD G. SMITH

\* \* \*

Private interests have applied to the municipality of Buenos Aires for permission to erect on public lands a tower similar to the Eiffel Tower in Paris. The proposed tower is to be 1067 feet high, to which is added a statue 106 feet high carrying a light to have an illuminating power of 1,000,000 candle-power. The total height thus would be 1173 feet as compared with 984 feet of the Eiffel Tower.

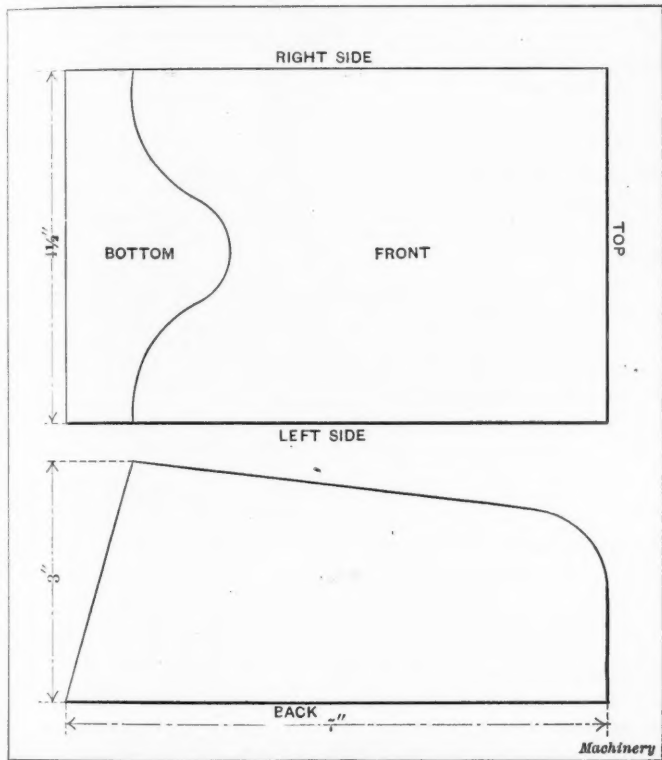
## HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

### A PROBLEM IN PRESSWORK

P. B.—I wish to make a set of dies for drawing a steel shell like that illustrated in the sketch. The material is 0.030 inch sheet steel. In referring to the sketch it should be stated that the bottom and back are open, thus the shell has a front, top, right and left sides only (no bottom or back). The fin-



ished piece must have sharp corners as indicated. I would like suggestions as to the proper method of drawing this piece, the number of operations that will be required and any other points that will be helpful.

This question is submitted to our readers.

### HOW TO CALCULATE THE POWER OF A PRESS

C. O. S.—The accompanying illustration Fig. 1 shows a press which is used for compressing springs and the writer would like to know how to calculate the power developed by the press, or, in other words, what spring tension would be sufficient to prevent the press from turning over. The press is driven by four-inch double leather belting and has a 30-inch balance wheel which weighs 420 pounds and runs at 100 revolutions per minute. The length of the stroke is 10 inches.

Answered by William L. Cathcart

A.—The data in this case are insufficient for wholly accurate results but, by reasonable assumptions, a fairly satisfactory answer can be given. There are two questions to be considered. First: What power is available in the stored or kinetic energy of the balance wheel and the gears driven by it for spring-compression by the plunger? Second: What spring-pressure, acting on the plunger, will hold the balance wheel stationary against the maximum pull of the belt?

#### Kinetic Energy

The stored or kinetic energy of a body rotating about a fixed axis—as the balance wheel does in this case—varies directly as the moment of inertia of the revolving mass about that axis, and the magnitude of the moment of inertia increases with the weight of the body and with the distance of that weight from the axis. In this case, the balance wheel A, the spur gears B and C, and the eccentric disk D revolve together, and hence they all have kinetic energy. To calculate with accuracy its amount for all of these parts is im-

possible, owing to lack of dimensions, and is unnecessary for practical purposes, since nearly all of the kinetic energy is stored in the rim of the balance wheel. This is due to the fact that the arms or disk of the balance wheel between the rim and hub are light and located near to the axis as compared with the rim, that the hub of the wheel and the whole of gear B are too near the axis to have any material effect, and that gear C and disk D run at only 26.7 revolutions per minute. An allowance of 10 per cent of the stored energy of the rim of the balance wheel should be ample to cover the similar energy of these parts.

The balance wheel is 30 inches in diameter and weighs 420 pounds. In similar wheels for heavy work, the weight of the rim is from 70 to 75 per cent of the total weight. On this basis, the maximum weight of the rim will be  $420 \times 0.75 = 315$  pounds. If we assume that the rim has a 5-inch face and is  $2\frac{3}{4}$  inches thick, its weight (cast iron = 0.26 pound per cubic inch) will be 306 pounds, which is close enough. The moment of inertia of this rim is 12.43. Its kinetic energy at 100 revolutions per minute is 681.28 foot-pounds.

#### Belt-pull and Turning Moment

According to the experiments of F. W. Taylor on oak-tanned and felled leather belts, a double belt having an arc of contact of 180 degrees will give an effective pull on the face of the pulley of 35 pounds per inch of width of the belt. On this basis, the four-inch double belt used in this press will give a maximum effective pull of  $35 \times 4 = 140$  pounds

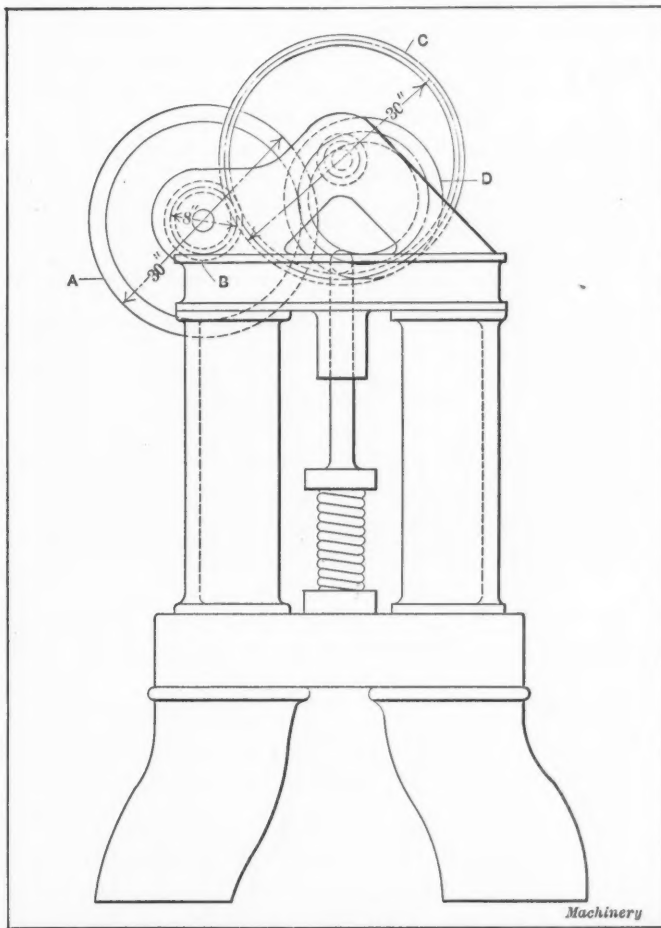


Fig. 1. Diagram of Press used for compressing Springs

at the pulley-face, with a leverage of 15 inches. This corresponds to a pressure, at the line of contact P of gears B and C, of  $140 \times \frac{15}{4} = 525$  pounds. The maximum pull of the belt will therefore drive gear C with a force of 525 pounds, acting with a leverage of 15 inches.

#### Brake Action

In compressing a spring under the press, the spring reacts on the plunger with the same force as that with which it is compressed. This force Q acts upward along the plunger and produces pressure and resulting friction, both in the eccentric cam-way D and in the bearing of gear C, to which the eccen-

tric disk is fixed. The resisting force of friction  $F$  acts along, or tangent to, the surfaces in contact. It is equal to the perpendicular pressure on those surfaces, multiplied by the coefficient of friction  $f$ . This coefficient is a factor which is theoretically indeterminate. Its value depends on the character of the surfaces in contact, their temperature, lubrication, etc., and differs in different machines, in different parts of the same machine, and often at different times in the same bearing. Various values of  $f$  have been found, ranging from 0.12 to 0.6. The calculation of the friction of a press during the downward stroke of the plunger would be a complex process. For simplicity, take  $f = 0.3$  and assume the entire friction to be concentrated at the top of the roller in the plunger. The distance of this point from the center of gear  $C$  is at least 11 inches when the plunger is at the bottom of its stroke. At this time the resisting force of friction  $F$  is equal to  $f \times Q$  or  $0.3 Q$ , which acts with a leverage of 11 inches.

If the kinetic energy has already been expended in compressing the spring, so that the belt alone is driving the plunger, the force  $F$  will just stop the press when its moment is equal to that of the driving force on gear  $C$ , due to the belt alone, that is when:

$$F = 525 \times \frac{15}{11} = 716 \text{ pounds}$$

$F = 0.3 Q$  and hence:

$$Q = 716 \times \frac{10}{3} = 2387 \text{ pounds.}$$

The safe working load of a helical spring of  $\frac{3}{4}$ -inch round steel and  $4\frac{1}{4}$  inches outside diameter, is approximately 2475 pounds so that such a spring, under these conditions, would just about stall the press at the lower end of the stroke.

#### Work of the Kinetic Energy

The energy stored in the rim of the balance wheel is 681.3 foot-pounds. Allowing an additional 10 per cent for the kinetic energy of the other rotating parts, gives 750 foot-pounds as the total kinetic energy. The stroke of the plunger is 10 inches or  $\frac{10}{12}$  foot. If spring compression occurs during the entire stroke, the average load on the plunger during the stroke will be:

$$750 \times \frac{12}{10} = 900 \text{ pounds.}$$

At the beginning of the stroke the load is zero, so that the

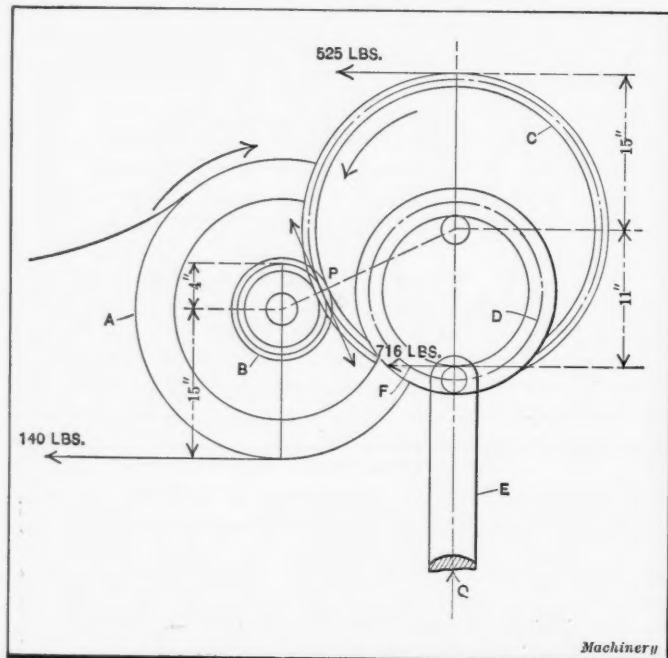


Fig. 2. Diagram showing Direction of Forces acting on the Press

load at the end will be  $900 \times 2 = 1800$  pounds, which should not exceed the safe working load of the spring thus compressed. This calculation neglects the resisting effect of the force of friction  $F$ , which may be considered thus: If  $Q$  is the average pressure during the plunger-stroke, then  $F = 0.3 Q$

pounds will act at an average radius from the center of gear

$C$  of at least  $\frac{11+1}{2} = 6$  inches during the semi-revolution of

that gear in which spring-compression occurs. The 750 foot-pounds of kinetic energy are equivalent to a force of 478 pounds acting through the semi-circumference whose radius is 6 inches  $= \frac{1}{2}$  foot and whose length is 1.57 foot. The net driving moment is then:

$$(478 - 0.3 Q) 1.57 \text{ foot-pounds,}$$

and this moment must be equal to the work done in compression by the plunger, which work is

$$Q \times \frac{5}{6} \text{ foot-pounds.}$$

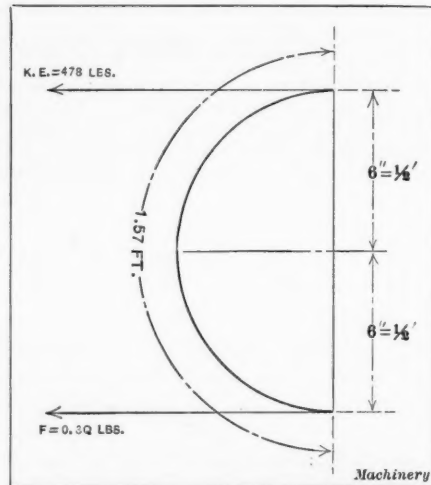


Fig. 3. Diagram showing Effect of Friction on the Power of the Press

Since the pressure of the plunger is equal to the reaction of the spring, we have:

$$(478 - 0.3Q) 1.57 = Q \times \frac{5}{6} = Q \times 0.83$$

$Q = 577$  pounds = average pressure during plunger-stroke.

The maximum pressure at the end of this stroke is  $Q \times 2 = 1154$  pounds, which should not exceed the safe working load of the spring thus compressed.

#### Work of Kinetic Energy and Belt-pull Combined

If the kinetic energy of the press is assumed to be wholly expended during the compression of the spring, the maximum pressure produced at the lower end of the plunger stroke will be as follows:

Pressure due to kinetic energy,	1154 pounds
Pressure due to belt-pull,	2475 pounds
<b>Total</b>	<b>3629 pounds</b>

This is the safe working load of the spring thus compressed. This pressure may be exceeded somewhat, since the maximum belt-pull is assumed to act only at the end of the stroke, while it would probably restore, to some extent, the failing kinetic energy during the stroke.

It should be observed that these calculations are based on somewhat broad assumptions, due partly to lack of dimensions but mainly to the effect of friction on the work of the press. This latter question is complex and presents problems whose solution for such a machine can be but approximate. Practical tests are required for their determination.

\* \* \*

The use of ball bearings in machine tools is growing rapidly. One make of heavy vertical grinding machine has a "three-quarter ball bearing," that is, radial ball bearings at the top, ball thrust bearings at the bottom, and a phosphor-bronze bearing to take the radial load. Ball bearings are used in the idler pulleys of this machine, a position for which they are admirably suited. Friction losses are much reduced and narrow bearings can be used which, in itself, is often a consideration of much importance in the design of high-power machines. The use of ball bearings in machine tools is by no means new. Mr. John Becker, president of the Becker Milling Machine Co., Hyde Park, Mass., tried them in 1893, but the inaccuracy of balls and the low grade of steel then used caused so many failures that he abandoned their use. The advent of balls accurate to one-ten-thousandth inch, made of alloy steel having high physical characteristics and ball races of the same high-grade metal, has completely changed the situation. What was unreliable twenty years ago is now probably the most durable thing in the way of bearings that has ever been made.

# NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS  
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

## WELLS BROS. CO.'S SELF-OPENING DIE

Wells Bros. Co., Greenfield, Mass., has recently placed on the market a new form of self-opening die. The design of this die has been worked out with the view of combining the advantage of an opening die which does not have to be backed off the work, with the accuracy of a solid die. The

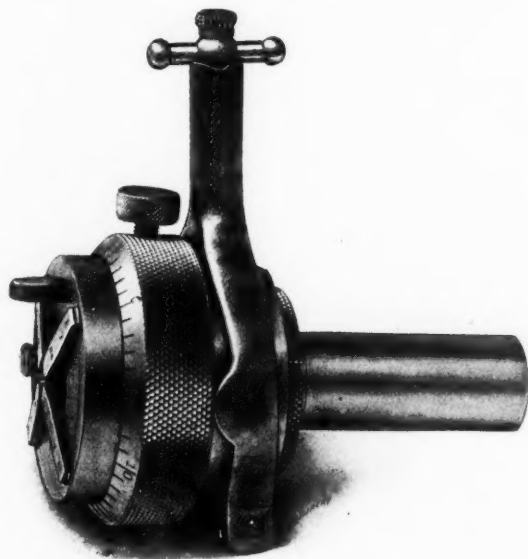


Fig. 1. The Wells Self-opening Die

chasers of this die are hinged at the back and supported by a sleeve which engages a tapered section located directly behind the cutting edges. In this way a solid and unyielding support is provided at the back of the chaser, directly opposite the cutting edges which do the heaviest work. In addition, the chasers are given lateral support on each side by the body of the die. The result of this construction is a die that possesses practically the same strength as a solid die. The shell which holds the chasers to their work slides over the

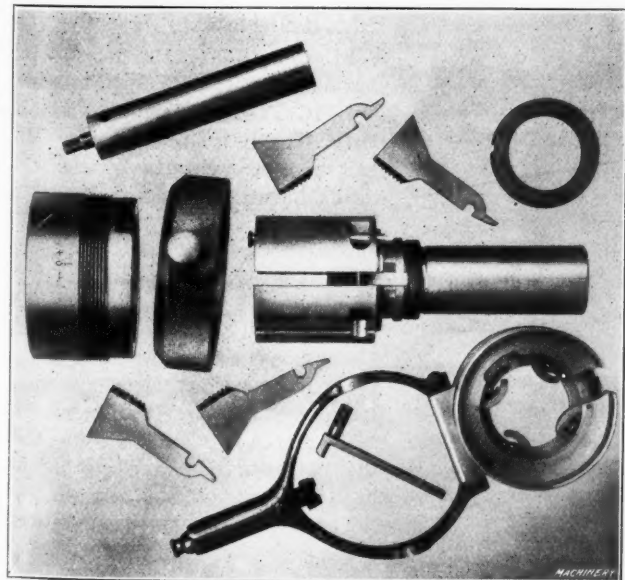


Fig. 2. Parts of the Wells Self-opening Die

body of the die longitudinally instead of having a rotary motion. The position of this shell is adjusted by a ring fastened to it. By this means, adjustments as fine as 0.00025 inch can be made. This adjustment is provided to take up slight variations from the standard size of the die. For this purpose, it is merely necessary to loosen the locking nut  $\frac{1}{8}$  turn and then move the graduated ring through one point for each 0.001

inch of adjustment that is required. After this adjustment has been made the nut is re-tightened.

This die is made in several different styles in which different types of tripping devices are used for automatically opening the die. This makes it adaptable for service on a variety of machines. One trip is operated by a pin which projects from the face of the die. When this pin comes into contact with the chuck or some other stop arranged on the machine for that purpose, it releases the latch and allows the springs to open the chasers. Another form of trip is internally operated. The advancing end of the work strikes a projection in the center of the die which releases the latch and opens the chasers. Still another form of trip is placed on the rim of the head. The latter type is particularly adaptable for use on drill presses and other machines which require the head to revolve. In this form of die head, a projection on the side strikes the latch in the rim and causes the die to open. In addition to the tripping mechanisms previously referred to, nearly all models of die heads are provided with a hand lever trip which is found to be a great convenience in setting up the die head. The releasing springs which open the die operate

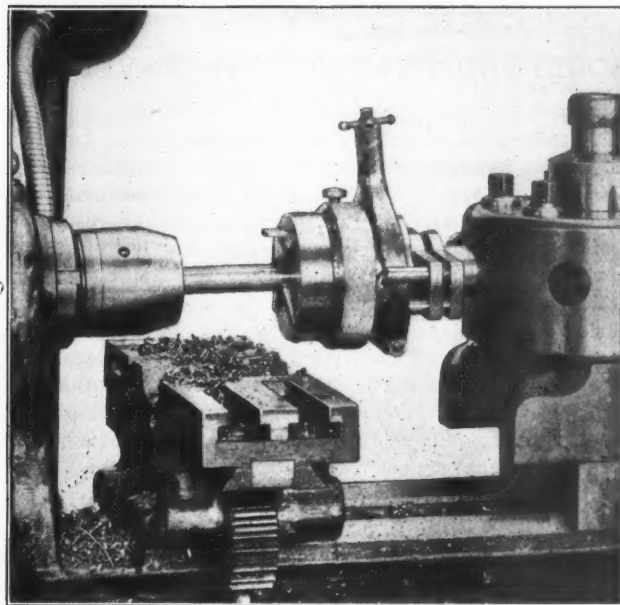


Fig. 3. Wells Self-opening Die in Use

directly upon the chasers, causing them to fly apart with "cat-like" quickness which would be impossible with any rotary method.

The tripping mechanism is entirely separate from the releasing springs, thus enabling a very light "hair trigger" latch to be adjusted. This minimizes the pull on the thread to such an extent that it never disturbs the lead of the thread, is absolute in operation, and opens so quickly that the thread is not scratched. Some models of this die head are mounted on an independent shank which permits the die to carry its own lead unaided by the machine. Experience has shown that a die will reproduce its own thread unless hindered by the machine or by some other external means. It is a very difficult matter to cam a screw machine so that the advance of the turret will be in exact time with the lead of the die. The resulting thread is always a compromise and imperfectly formed to that extent. By utilizing the independent shank, which permits a lateral float, it is possible to cut a  $\frac{1}{2}$ -inch-13 or a  $\frac{1}{2}$ -inch-12 thread on the same machine without making any changes or adjustments. One-half inch rods have been threaded for a distance of 28 or 30 inches with this die. Allowing the die to carry its own lead, the total variation in the lead of the threads for the entire distance is 0.010 inch.

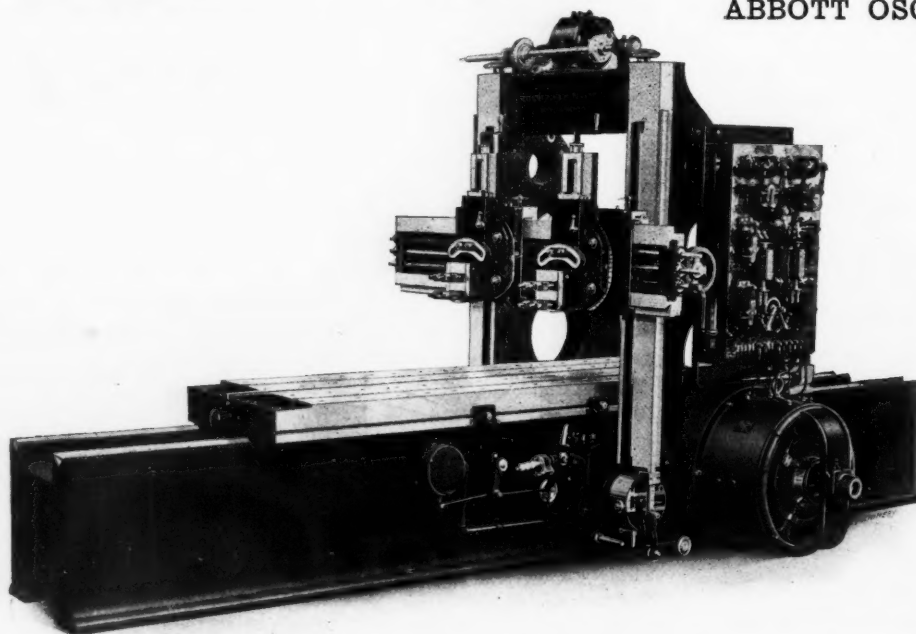
Fine chips and metal dust will work into the parts of any mechanism. The construction of this die head is so easily

understood that it can be quickly opened and cleaned by an unskilled employe. The die has few parts and is extremely simple in design and construction. The parts are easily assembled. As lubricant is brought to the work through the shank, the flow washes chips and dirt away before there is any chance of their lodging between the parts.

This die is made in the following styles: The Model V is equipped with the internal trip, face trip and hand trip. One exception to this standard equipment is that from 1½ inch up, the internal trip is not furnished. The Model VV is the same as Model V with the addition of a separate shank which enables the head of the die to float (longitudinally only). The Model X was designed to meet the demand for a die in which the chasers could be quickly changed from one size or style to another. At the base of each chaser, there is a small pawl held in position by a spring, the entire mechanism being mounted on the inside of a collar. The hand lever is attached to this collar and by turning the lever about ¼ of a revolution to the left, the pawls slide off the bases of the chasers, enabling them to be taken out by hand. A new set of chasers is then placed in position and the hand lever turned back to fasten them in position. This model has the same tripping mechanisms as the Model V. The Model XX is the same as the Model X, except that it is also provided with the shank to enable the die to float longitudinally. The different forms of die heads which are provided for by these models will undoubtedly meet the requirements of a great variety of threading operations on different classes of machines.

#### ROCKFORD PLANER WITH REVERSING MOTOR DRIVE

The 36-inch by 36-inch by 10-foot planer shown in the accompanying illustration is a product of the Rockford Machine Tool Co., Rockford, Ill. This machine is equipped with reversing motor drive and its design represents the result of a careful study which has been made with the view of simplifying the construction as far as possible. The motor is designed with a special type of frame which is bolted to a pad on the housing of the planer. This makes the machine a self-contained unit and does away with the trouble of keeping the planer and motor in perfect alignment with each other when the two units are mounted on separate foundations. The length of the shaft is also shortened and the use of a coupling is avoided so that considerable floor space is saved. The dan-



Rockford 36-inch by 36-inch by 10-foot Planer with Reversing Motor Drive

ger arising from an exposed coupling is also done away with. When it is necessary to dismantle the motor for repairs or inspection, the armature is easily removed by driving out the gib head key and taper pin from the main driving pinion and set collar, and then removing the outside head from the

motor frame. A separate motor is used for raising the cross-rail which is operated from the left-hand side of the machine.

#### THE GREENERD ARBOR PRESS

The No. 7 Greenerd arbor press, illustrated herewith, is the largest equipment of this type that has been brought out by Edwin E. Bartlett, 326 A St., Boston, Mass. This press receives work up to 36 inches in diameter. The only change from preceding presses of this type lies in the greater power and capacity of the No. 7 press. This machine has a leverage of 250 to 1, and a pressure up to 25 tons is easily obtainable.

When the lever is in the position shown in the illustration, the rack or ram may be easily moved up or down by means of the handwheel. The knee is operated by a crank which rotates the screw through a pair of miter gears. This screw runs in a nut at the base of the machine and the design is such that the knee can be lowered to its extreme position without the screw reaching the floor. This makes it possible to place a press in any position without cutting the floor to provide clearance for the screw. The knee is held to the frame by two studs and nuts. These nuts are adjusted and locked in place in such a way that the knee can be easily moved. The pitch of the elevating screw is such that these nuts do not require to be tightened to hold the knee under the heaviest pressure.



No. 7 Greenerd Arbor Press with Leverage of 250 to 1 and Capacity up to 25 Tons

#### ABBOTT OSCILLATING BURNISHING BARREL

In order to meet the demand for a burnishing barrel that will take work over 16 inches in length, the Abbott Ball Co., Elmwood, Hartford, Conn., has brought out a new form of oscillating burnishing and tumbling barrel. The machine is shown in different positions in Figs. 1, 2 and 3, from which a general idea of its design can be obtained. The inside dimensions of the barrel are 12 inches in width by 30 inches in length. It is octagon in shape and lined with hard maple. One end of the barrel can be removed by loosening four nuts on swing bolts, thus releasing the cover so that it can be lifted from the barrel.

The barrel is supported on trunnions in a yoke, the sides of which are made of channel irons. The most important feature of the design is the locking mechanism which secures the barrel in place. This consists of two gear segments, one of which is carried on the spindle which supports the barrel in the yoke and the other by a bolt which slides in a slot in the yoke. By this means the axis of the barrel can be set at an angle of 5, 10 or 15 degrees with the plane of the yoke, and clamped in this position by bringing the gear segment on

the yoke up so that it meshes with the corresponding segment on the spindle, and then clamping it in place by tightening the bolt. In the parallel position, the barrel is clamped by a slot in the opposite end of the sliding lock member which

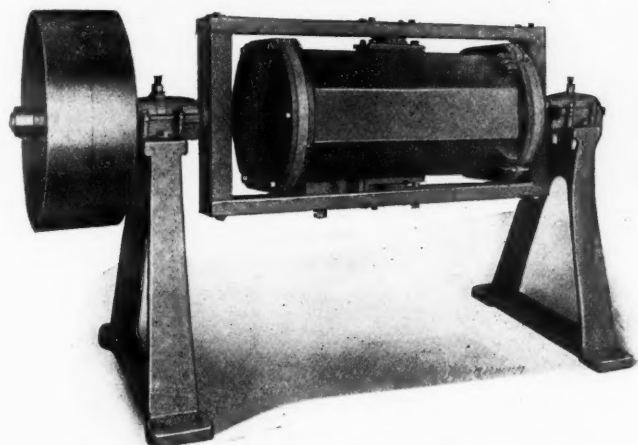


Fig. 1. Abbott Burnishing Barrel clamped Straight in Yoke

engages with a lug cast on the barrel. Fig. 1 shows the barrel clamped parallel with the yoke; Fig. 2 shows it clamped at an angle; and in Fig. 3 the clamp has been released, the cover removed and the barrel swung down to discharge its contents.



Fig. 3. Abbott Burnishing Barrel swung down to discharge Contents

This method of taking the end out of the barrel greatly facilitates loading or unloading the contents which are to be burnished in it.

When the barrel is locked in either of the angular positions, it imparts an oscillating motion to the contents. Experience will show the most desirable angle for different classes of work. Instead of filling the barrel one-half or two-thirds full of work and balls, as in the case of other types of burnishing barrels, this barrel should be almost entirely filled. The special soap-chips and water are used in the customary manner. In this way the work has no chance to turn on end or to move as it would do in a barrel of smaller diameter which is only partially filled. Small work, however, can be more satisfac-

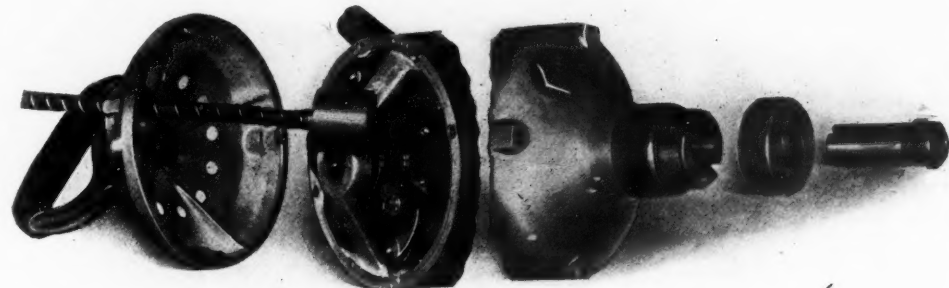


Fig. 2. Details of the Commutator End of the Motor and of the Socket

torily finished in the regular type of burnishing barrel, the purpose of the oscillating barrel being merely to take care of larger sizes of work such as sash rods and similar pieces.

## HISEY-WOLF PORTABLE ELECTRIC REAMER

The Hisey-Wolf Machine Co., Cincinnati, Ohio, has placed on the market a portable electric reamer adapted for use in boiler shops, structural and steel works, etc. In the manu-

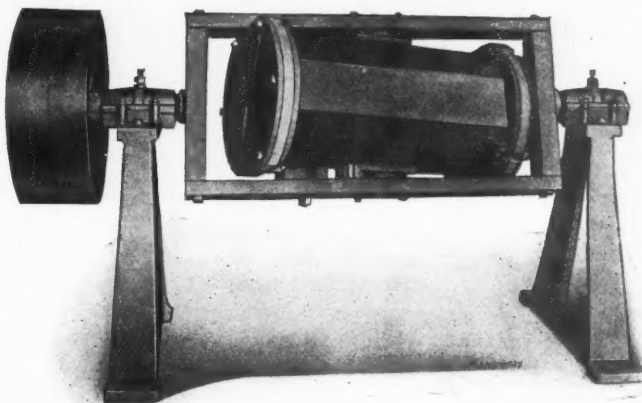


Fig. 2. Abbott Burnishing Barrel clamped at an Angle in Yoke

facture of structural iron and steel, boiler plate and similar work, it is the practice to cut, shape and punch the parts according to specifications which are furnished to the mills. It is not practicable, however, to punch holes with sufficient accuracy to have them line up properly for making riveted connections. This has led to the practice of punching holes under-size, thus leaving sufficient metal for them to be lined up and sized by a reaming operation at the time that the riveting is done. It is for this kind of work that the new Hisey-Wolf reamer has been designed.

This tool consists of a compact electric motor with speed reduction gears which drive the socket at a suitable speed for the class of work for which the tool is intended. A long

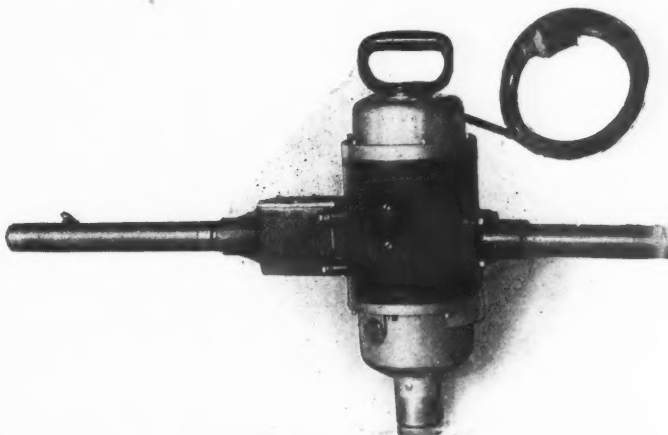


Fig. 1. Hisey-Wolf Portable Electric Reamer

handle is provided at each side of the tool and a short handle at the end opposite the reamer socket. A switch of special construction is mounted in one of the side handles, which affords a simple and effective means of making and breaking the electric contact quickly and without danger of short circuiting or shocks. By this means the motor is kept under control of the operator at all times. The motor is designed especially for driving this tool. It is of the bipolar type and made as light as is consistent with the power requirements of the service for which the tool is intended. The motor is air-cooled by a specially designed fan placed on the rotor shaft close to the gear-box. This fan discharges through a series of small openings near the circumference of the end-housing, the inlets being through openings in the opposite end-housing. These openings are covered by fine wire mesh to protect the motor from having borings and

other material drawn into it. The motor windings are heavily compounded to provide a strong starting and operating torque at a low speed, and without danger of damage from racing when the tool is free.

The gears are cut from steel and carefully hardened and mounted in an enclosed gear-box which is an integral part of the motor housing. The gears run in grease and have self-aligning ball bearings. Referring to Fig. 2, which shows the construction of the commutator end of the motor, it will be seen that the bearing is mounted on a casting which is entirely independent of the end-housing. With this construction the frictional load of the bearing is not increased or affected by pressure applied on the handle. The motor terminals are protected by a fiber insulating cap.

The socket is of the slip type and is machined to Morse tapers of the proper dimensions for standard sizes of reamer shanks. The construction is such that the reamer may be easily removed, it being merely necessary to unscrew the knurled cap by hand. This releases the slip socket into which the shank fits. No spanner or wrench is necessary, as the slip socket which holds the shank fits loosely into the socket of the driving spindle and engages it positively by means of recesses provided for that purpose. Excessive pressure resulting from severe work cannot affect the proper alignment of the shank.

### SIXTEEN-INCH CINCINNATI ENGINE LATHE

The illustrations show a 16-inch lathe which has been placed on the market by the Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio, and the arrangement of the reverse plate and apron with which the machine is equipped. This lathe is provided with any one of three types of headstock; the first has a three-step cone pulley with double back-gears and the other two, four- and five-step cones with single back-gears. The spindle is of high carbon forged steel, ground and lapped to an accurate fit. The spindle bearings are bushed with a special grade of bronze which is made for this purpose. The thrust is taken by a bearing at the rear of the spindle, which is provided with a hardened tool-steel collar for taking up wear. The thrust is taken against the front end of the rear bearing. Lubrication of the spindle bearings is provided for

cut that the main driving belt will pull. Motion is transmitted by compound gearing and the longitudinal and cross feeds can be started, stopped or reversed while the lathe is running. These feeds cannot be engaged, however, when the lathe is employed in screw cutting operations and this provision constitutes a safeguard against damage to the machine when it is being operated by an inexperienced mechanic. A thread-chasing dial is provided, which permits the halfnuts to be opened, the carriage run back by hand and the thread picked up at any point without reversing the lathe. This makes a backing belt unnecessary. An automatic stop has also been provided for tripping the feeds at any required point. The carriage is gibbed at both the front and back and has a bearing on the vees of the bed for its entire length.

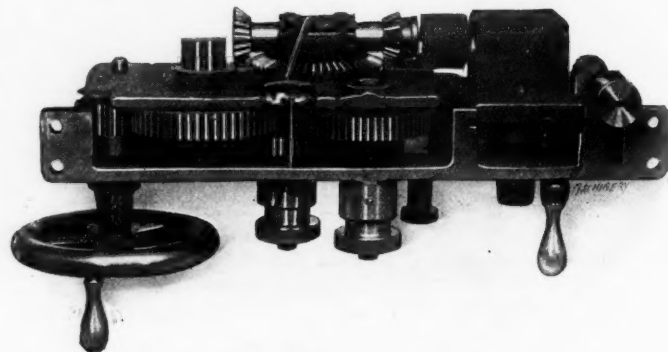


Fig. 2. Apron of the Cincinnati 16-inch Lathe

The reverse plate for cutting right- and left-hand threads is located on the outside of the headstock and is only used for reversing the lead-screw when cutting threads and not for reversing the feed. The feed reverse for the lathe is in the apron. A combination of metric pitches with a U. S. Standard lead-screw or *vice versa*—besides those obtained in the gear-box—may be obtained by simply shifting two levers. This arrangement gives the facilities of a standard lathe, and each gear not only provides for cutting the pitch required but also the other pitches which may be obtained through the series of gear-box changes. All changes can be made while the lathe is running under a heavy cut. The screw-cutting and feeding mechanism is characterized by its simplicity, compactness and

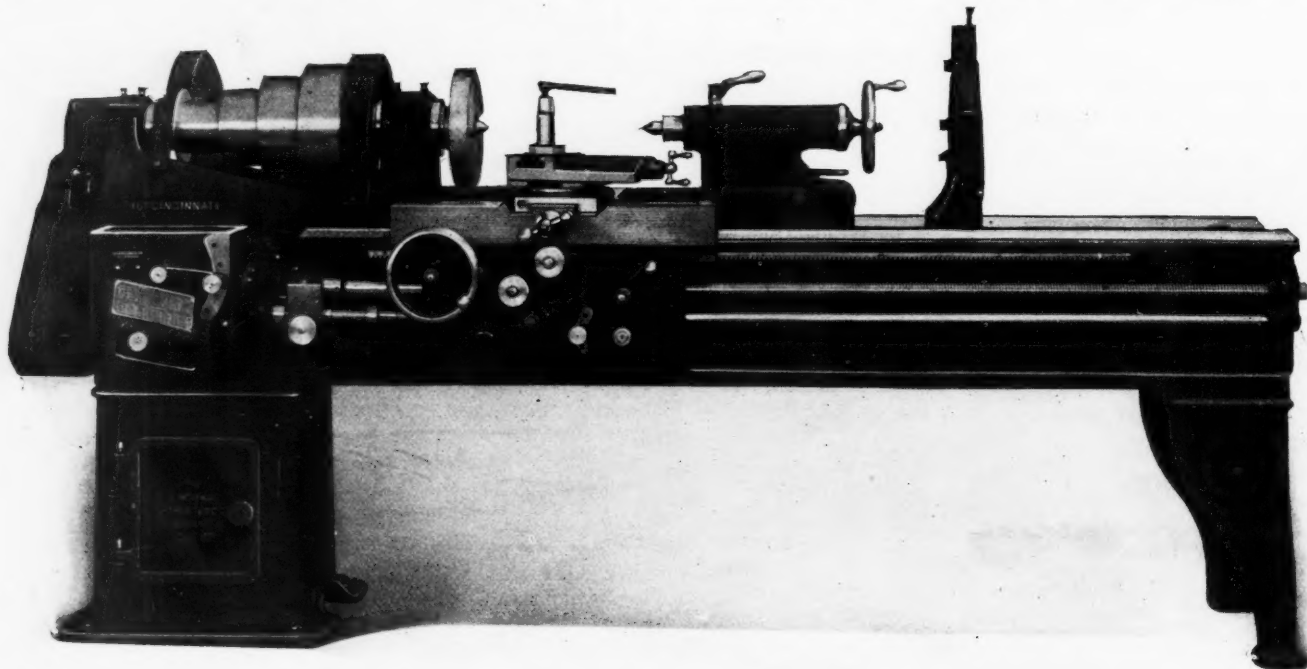


Fig. 1. Cincinnati 16-inch Lathe

by self-closing dust-proof oilers located on the bearing caps.

The machine side of the apron is shown in Fig. 2. This apron is of the double-wall type and is rigidly bolted to the carriage of the lathe. The double-wall construction gives additional support to all shafts and studs in the apron, thus providing accuracy as well as long life for all of the working parts. All of the gears are of ample pitch to withstand any

ease of manipulation. The device is a complete unit assembled in a box mounted on the front of the bed where it is easily accessible. The gears are made of steel and the shafts are of liberal proportions. All of the bearings are bushed with bronze and designed along lines which will enable them to withstand severe treatment. Provision for different threads is made without removing a gear, by simply operating two

levers which are conveniently placed within a few inches of each other. The index plate is attached to the box, and so placed that the operator sees at a glance the required setting for any thread or feed.

The tailstock is of the off-set type and has a long bearing on the bed. The spindle is securely supported and has a bronze nut for the screw. A clamp device is used to lock the spindle

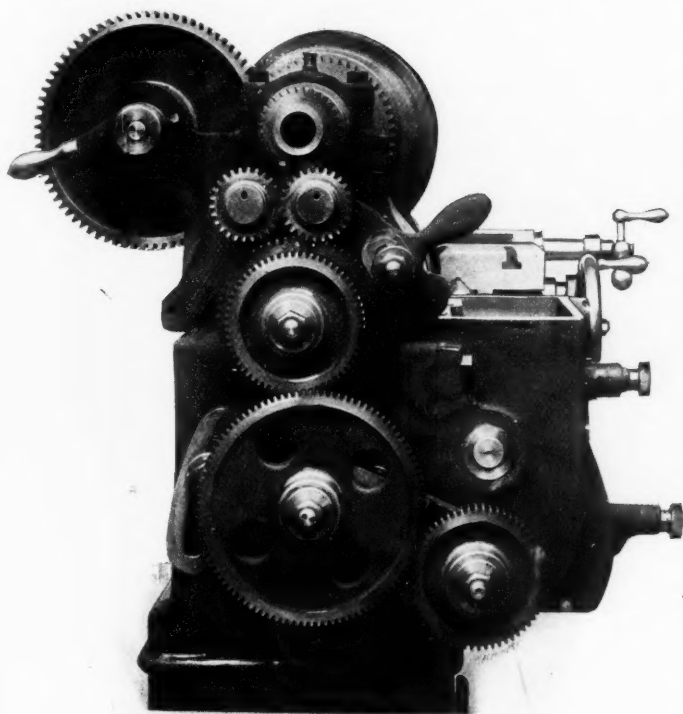


Fig. 3. End View of Cincinnati Lathe showing Reverse Plate and Segment

in any position, the design of which has done away with the necessity of splitting the barrel.

The countershaft is equipped with double friction and self-oiling clutch pulleys. It is not necessary to throw off the driving belts nor stop the countershaft when filling the reservoirs which carry the supply of lubricant. The hangers are of pressed steel and are of the double-brace type, provided with ring oiling bearings. On ordinary commercial work the countershaft is operated at 140 R. P. M.

### ATLAS BALL GAGES

The Atlas Ball Co., 203 Glenwood Ave., Philadelphia, Pa., has recently found a new use for the balls of its manufacture. This consists in using them for plug gages of the kind com-

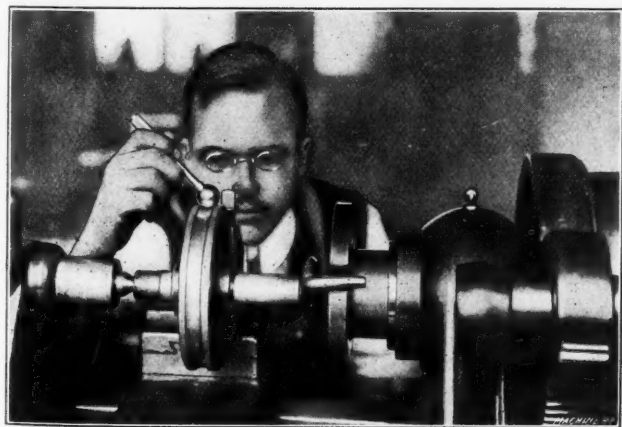
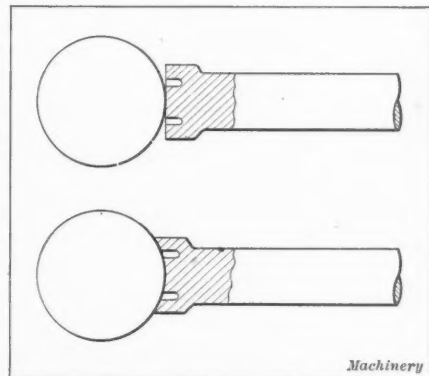


Fig. 1. Measuring the Radius of a Sheave Pulley with the Atlas Ball Gage

monly employed in machine shops. For this purpose, a knurled handle is electrically welded to the ball as shown, which makes it a very convenient tool. These gages are being made in sets of assorted sizes, and they are guaranteed round and accurate to 0.0001 inch. Two important advantages are secured by them. First: The substitution of a ball in place of a cylindrical plug enables the gage to be entered into the work in

any position, instead of requiring the axis to be parallel with the axis of the gage. Second: The scale on which these balls are manufactured enables gages of this kind to be offered at a price which is not prohibitive.

In the manufacture of its regular line of balls, the Atlas Ball Co. has used the Johannsens Swedish gage blocks to calibrate the measuring instrument which is used to check their accuracy. That this is a most delicate instrument will be readily appreciated from the fact that its entire range of measurement is only 0.002 inch. It is used to measure balls during the process of manufacture and especially after the precision grinding has been performed on them. Experience showed that constant use resulted in a slight hollow being worn in the points of the machine, which was responsible for a corresponding error in the reading obtained with it. To avoid this difficulty the method of setting the instrument with the Swedish gage block and then making subsequent calibrations with a master ball was adopted. As this ball was of the same shape and contour as the standard ball, the slight wear on the points of the machine was compensated for and enabled measurements to be made more accurately and more rapidly than could otherwise be done. While perfecting these measuring devices, Mr. Otto W. Schaum, president of the Atlas Ball Co., conceived the idea of attaching a handle to the ball for two reasons:



Figs. 2 and 3. Shank and Ball ready to be welded and the Welded Joint

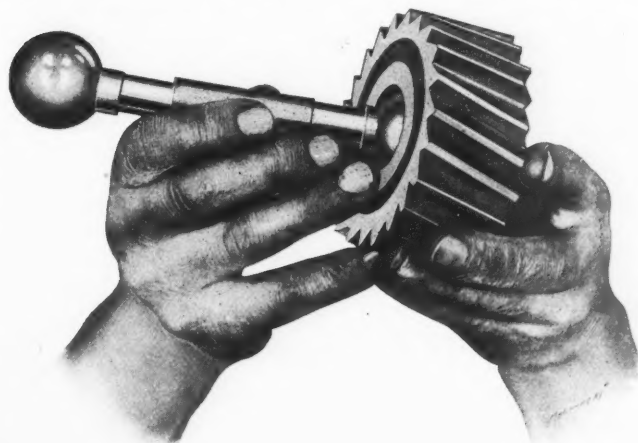


Fig. 4. Double End Atlas Ball Gage used as a Limit Gage

First, it would facilitate handling the master ball; and second, it would eliminate errors due to expansion and contraction caused by holding the master ball in the hand for too long a period.

The convenience of this tool suggested the application of the same idea in making the usual form of plug gages and similar tools. Tools of this kind can be conveniently used for setting a micrometer, thus preventing the chance of having a workman read it incorrectly. They can also be used as a radius gage for rolling mill rolls of the type used for producing round sections, or for measuring the radius of a sheave wheel, as shown in Fig. 1. Probably the most important application of these tools will be found in measuring internal diameters on ball bearings, circular saws, form cutters, gear wheels, flywheels, pulleys, hollow mills, collars, bushings, and a variety of other machine parts.

The method of attaching the ball to the handle was selected with the view of eliminating any tendency toward distortion. It was, of course, necessary to find some means by which a hardened and ground ball could be attached to the handle, as the distortion produced by the hardening process would ruin

the accuracy of the gage. After trying a number of methods, electric welding was found to give very satisfactory results, certain modifications of the customary method being applied to prevent drawing the temper of the ball. Fig. 2 shows the handle in position ready to be welded, and Fig. 3 shows a sectional view of the handle welded in place on the ball. Referring to these illustrations it will be seen that the central projection on the handle is melted away sufficiently so that the ball has an even bearing on the end of the handle.

Fig. 4 shows one of the Atlas ball gages being used as a limit gage. It will be seen from the illustration that in this case there are two balls, one attached to each end of the shank. The balls on this particular tool are 1.251 and 1.249 inch in diameter, these two sizes constituting the extreme limits between which the diameter of the hole in the cutter must lie. The shank which carries the larger ball is of greater diameter than that which carries the smaller ball, so that the workman is able to distinguish the two ends of the gage readily, without referring to the sizes which are stamped on the ends of the shank. Fig. 5 shows the application of the gage for gaging a hole which has been bored in the wheel shown mounted in a lathe chuck. This illustration shows the advantage of a spherical end over a cylindrical end for a gage of

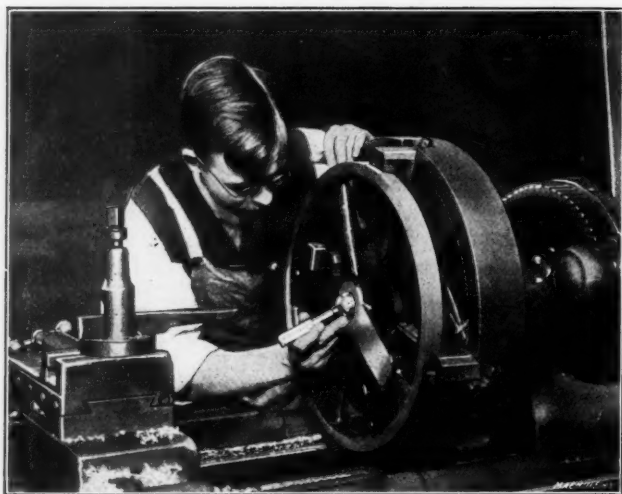


Fig. 5. Gaging the Bore of a Pulley with the Atlas Ball Gage

this type. Referring to the illustration, it will be seen that the gage can be placed in the hole at any angle without danger of jamming it, as would be the case with a cylindrical plug gage.

### GARVIN DUPLEX HORIZONTAL DRILLS

The illustrations show a new line of duplex horizontal drills, recently brought out by the Garvin Machine Co., Spring and Varick Sts., New York City. These machines are adapted to machine work from opposite ends simultaneously, using suitable fixtures for drilling, counterboring, turning or hollow-milling. Facing is done in practically one-half the time consumed in single spindle operations, and the machine provides for positive alignment, which is also an additional advantage. The rapidity of operation depends largely upon the style of fixture used.

With a view of entirely avoiding chip troubles, the machines were designed with large vee guides for the heads, leaving an open bed free from the accumulation of chips. The No. 00 machine is made with both screw and rack feed, having a capacity for  $\frac{7}{8}$ -inch and  $\frac{3}{4}$ -inch drills, respectively. The rack feed machines, shown in Figs. 1 and 2, are made in four styles (A, B, C and D). The heads slide on generously proportioned vees, and are taper gibbed underneath to take care of lifting strains and wear. It will be noticed that there is a centrally located depressed surface, 12 by 12 inches in size, with a central T-slot planed out of the solid. This T-slot is square with the vees and provides a means for clamping fixtures and for changing them quickly. The thrust of the spindle is taken on ball races.

The heads of the No. 00-A duplex horizontal drill shown in Fig. 1 are controlled independently by hand capstan wheels,

suitable micrometer stops being provided for accurate facing work. The capstan wheels have two working positions for long or short pieces. On the "B" style of drill the heads are moved simultaneously by hand through a centrally located capstan, operating through a rack and pinion feed. A friction clutch device provides for disengaging the left-hand head, allowing for a close adjustment to cover variation in the length of drills or turning tools. This also provides an adjustment for wear of the tools in sharpening. With this in-

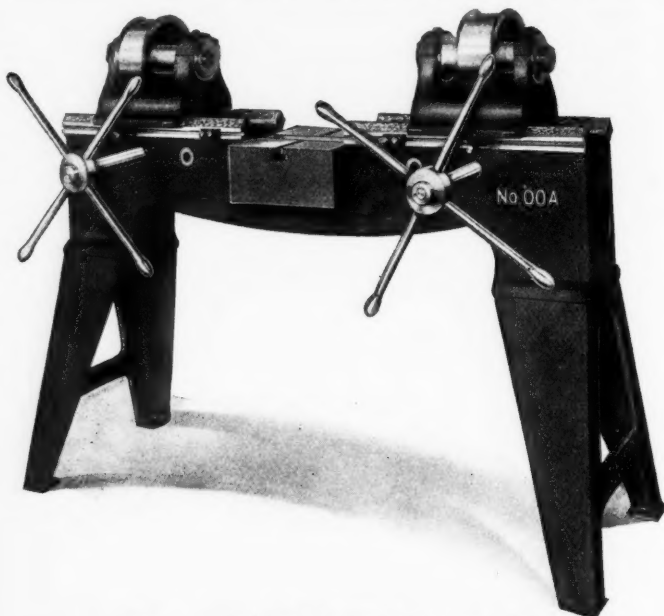


Fig. 1. Garvin No. 00-A Duplex Horizontal Drill

dependent friction adjustment, various other operations, such as turning to exact shoulders, or facing to exact lengths are fully controlled.

The "C" style drill, shown in Fig. 2, is the same as the "B" style, except that it is equipped with power feed, which feeds both heads simultaneously. There are three changes of feed, and automatic adjustable trip stops and micrometer stops are provided. A noteworthy feature of these drills is that on tripping the feed, the heads are returned immediately to their

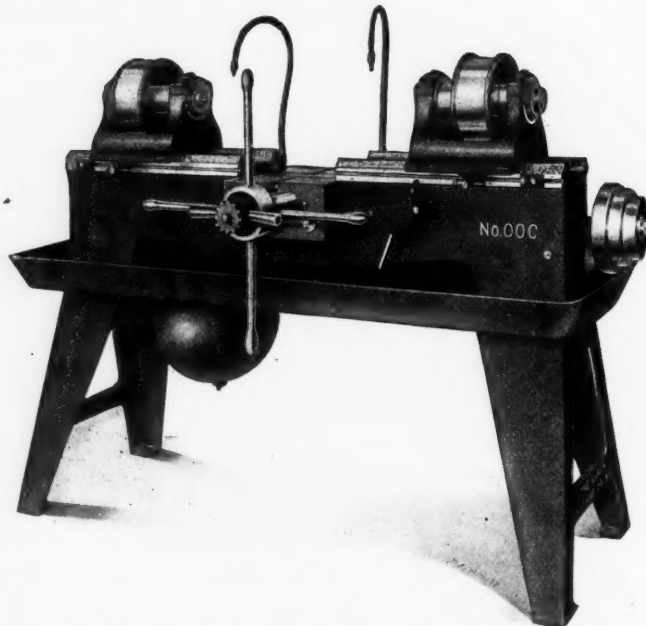


Fig. 2. Garvin No. 00-C Duplex Horizontal Drill equipped with Power Feed

original positions through the unwinding of an adjustable barrel spring. The spindles are hardened and ground and run in bronze boxes. The "D" style of drill is made to cover numerous special requirements in duplex drilling, the sliding heads being replaced by sliding plates. Various single or multiple drilling heads can be mounted on these sliding plates and fed independently by hand, as in style "A"; simultaneously by hand, as in style "B"; or with automatic power feed, as in style "C" drills.

### AURORA DRILL WITH POSITIVE GEARED FEED

The 24-inch upright drill equipped with positive geared feed and shown in Fig. 1 is a new model which has been developed by the Aurora Tool Works, Aurora, Ind. It will be seen that this machine is equipped with positive geared feed, and Fig. 2 shows a detail view of the gear-box. The feed gears are covered by a solid case which is filled with heavy oil and the feed gears are of hardened steel.

The spindle is made of high-carbon steel and is provided with quick-return, the thrust being taken on roller bearings. The spindle has a feed of 11 inches and is bored for a No. 4 Morse taper. The positive geared feed is provided with automatic stops and gives six changes ranging from 0.006 inch to 0.039 inch per revolution of the spindle. The machine is driven by a four-step cone pulley and the back-gears have a ratio of  $2\frac{1}{2}$  to 1; they are engaged or disengaged by a lever which is conveniently situated for the operator. The diameters of the cone pulley steps range from  $5\frac{1}{2}$  to 11 inches by 3 inches face. The tight and loose pulleys are 12 inches in diameter by  $3\frac{1}{2}$  inches face and should run at from 400 to 600 revolutions per minute.

The high drilling capacity which this machine has shown in recent tests is due to the size and width of the belts and also to the fact that the power is applied to the drill in a simple and direct manner. The combination of the most advantageous gear ratios, pulley diameters, and belt speeds also adds to its efficiency.

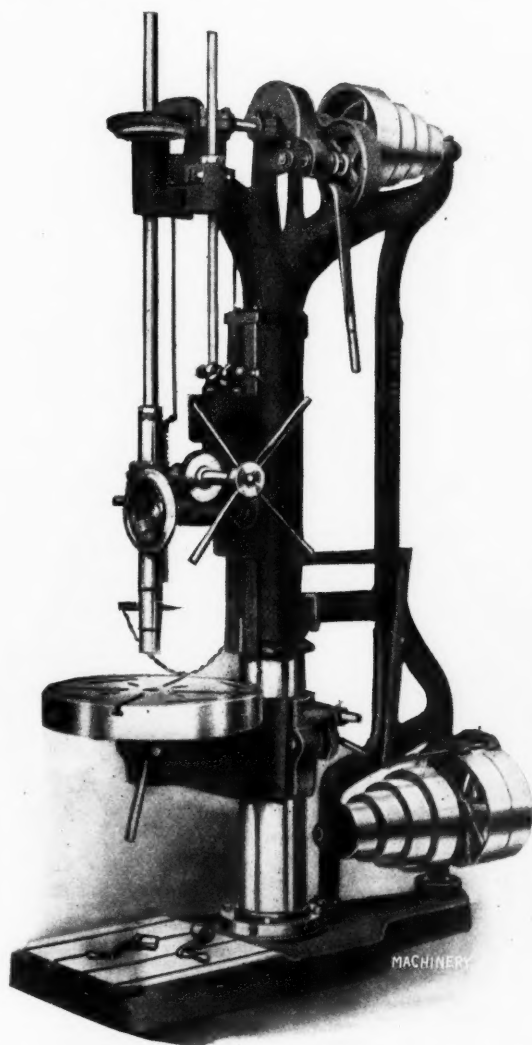


Fig. 1. Aurora Upright Drill equipped with Positive Geared Feed

The base is of massive construction and is provided with T-slots for holding large work which cannot be conveniently set up on the table. The maximum distance from the base to the end of the spindle is  $46\frac{1}{2}$  inches. The column is finished by grinding and the metal is well distributed to insure sufficient strength. The table is 22 inches in diameter and provided with bolt slots. The table arm has a long bear-

ing on the column and a large circular bearing in which the table rests; the construction gives exceptional rigidity. The table is raised and lowered by means of a rack and pinion and is locked by clamping screws. The maximum

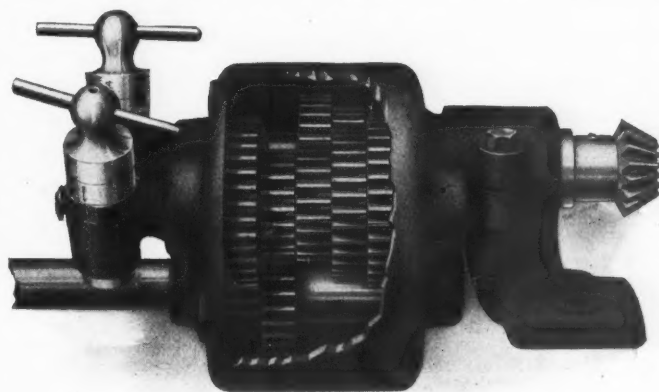


Fig. 2. Feed-box of the Aurora Upright Drill

distance from the table to the end of the spindle is  $33\frac{1}{2}$  inches. The height of the machine is 7 feet 6 inches and the floor space occupied 4 feet 7 inches by 1 foot 10 inches.

### TOLEDO DRAWING PRESS

The double-crank, double-action toggle drawing press illustrated herewith is a product of the Toledo Machine & Tool

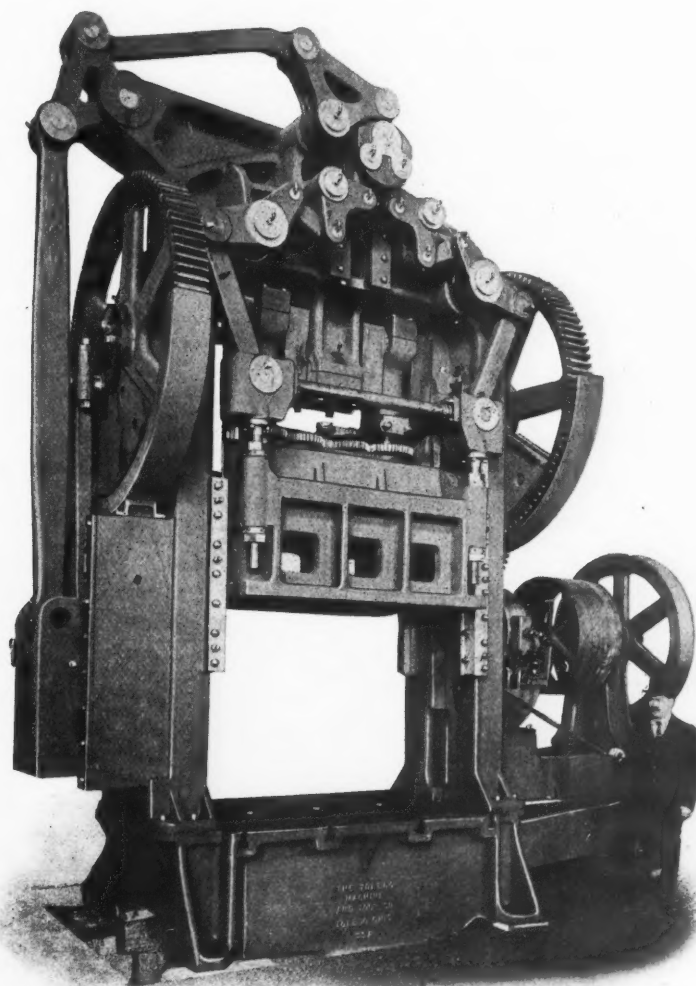


Fig. 1. Double-crank Double-action Toledo Toggle Drawing Press

Co., Toledo, Ohio. The design of this machine includes an entirely new feature in the method of operating toggle drawing presses. Referring to the illustration, it will be seen that the rocker shafts run through the solid arch of the press from front to back, and, as a consequence, they are much more rigidly supported and the distance between the toggle joint supports is considerably reduced. This reduces the tor-

sional strain to a minimum, especially on the wider patterns of double-crank machines. The mechanism used for transmitting power centrally to each of the two rocker shafts repre-

with any required width between housings. The machine illustrated in connection with this article has a width between housings of 84 inches; a plunger stroke of 29 inches; and a

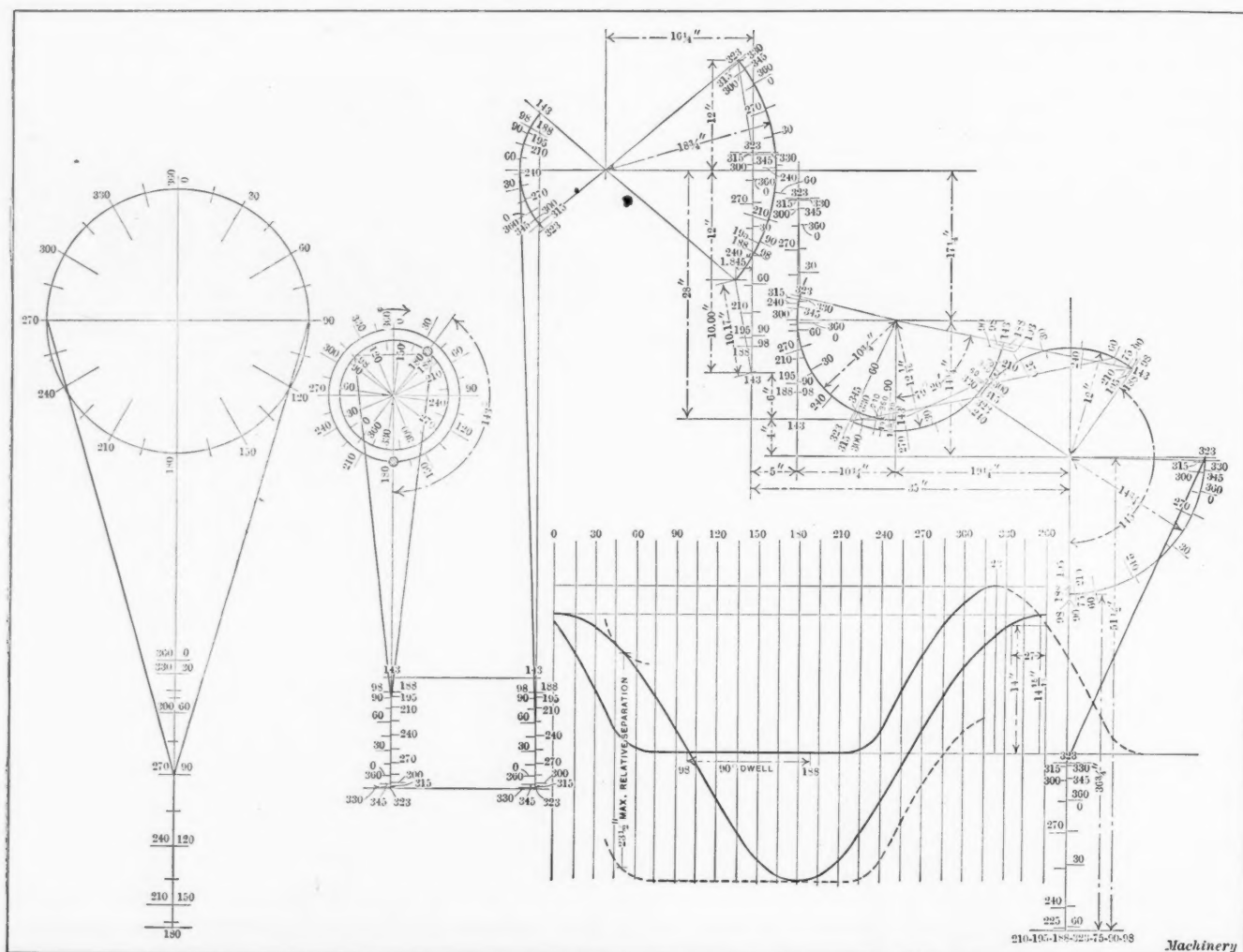


Fig. 2. Diagram showing Dwell of Blank-holder during the Drawing Operation

sents another new feature of this design. This also reduces the tendency toward torsional stresses between these shafts to a minimum, and simplifies the construction by only requiring power to be transmitted from the crankshaft on the left-hand side, thereby doing away with the additional driving mechanism required for transmitting power from both sides of the press.

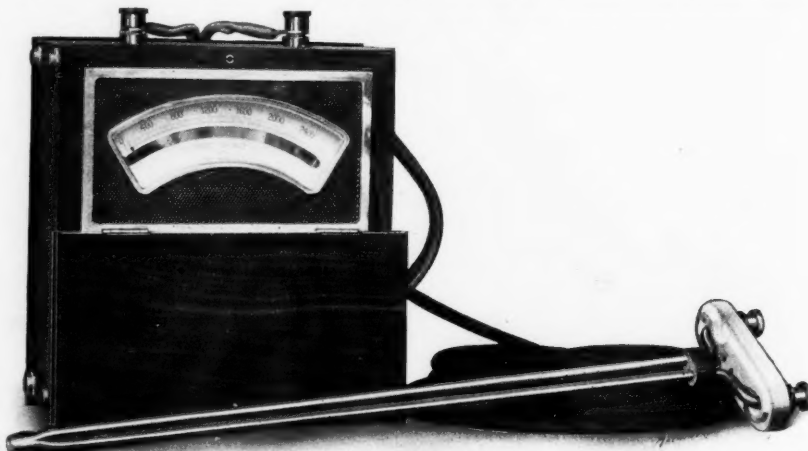
These new features, combined with the Toledo patented toggle movement—as used on the Toledo single-crank presses—give another advantage to this machine. The application of practically the same mechanical features on the double-crank machines that are used on the single-crank presses of this company's manufacture, provides for the absolute rest or dwell of the blank-holder during the drawing operation, through over 90 degrees of the plunger travel, as indicated by the diagram shown in Fig. 2. The advantages of this are twofold and may be briefly mentioned as follows: First, it facilitates drawing operations, especially on the finer gages of metal, and in such cases this feature is really essential to the attainment of satisfactory results. Second, any slight movement of the toggle arm and joint pin under the heavy pressures that are applied, not only caused a variation in the pressure applied during the dwell by the preceding forms of toggle movements which were used for this purpose, but also resulted in extreme wear on the pins. This difficulty has been entirely eliminated by the provision of the absolute rest or dwell which is obtained with the present type of machine.

This press is built in a variety of sizes and capacities and

blank-holder stroke of 18 inches. The complete weight of the machine is 135,000 pounds.

## BROWN MOLTEN METAL PYROMETER

The Brown Instrument Co., Philadelphia, Pa., has placed on the market an improved type of thermo-electric pyrometer which is intended for measuring the temperature of such metals as copper, brass, aluminum, bronze, etc., in the molten



### Brown Pyrometer for measuring Temperature of Molten Metal

condition. This pyrometer represents the result of experiments which have been conducted with the view of producing a thermo-electric couple that is capable of withstanding the action of molten metals for a reasonable length of time. The couple finally adopted for this purpose is made of nickel-alloy

rods  $\frac{1}{4}$  inch in diameter. The thermo-couple is plainly shown in the illustration, and on account of the large cross-section its life has been greatly increased.

A high-resistance portable indicating instrument is used in connection with this couple. The high resistance of the windings of this instrument makes its readings unaffected by changes in the length of the wire connecting it with the thermo-couple. In designing, the requirements of practical work have been borne in mind, and the construction has been worked out along lines which will enable it to be used in the foundry without danger of damage. The possible advantages of using a pyrometer in foundry work are quite generally recognized, but the delicacy of many forms of these instruments has been the cause of most practical foundrymen refusing to install them.

In using the present type of pyrometer, the thermo-couple is inserted in the molten metal before pouring. The temperature is obtained instantly in this way, and when it has once been definitely determined what constitutes the proper temperature of any metal for a particular class of work, the foundry can secure uniform castings of high quality by pouring them all at the proper temperature.

### "LITTLE DAVID" RIVETING HAMMER

An improved pneumatic riveting hammer has recently been brought out by the Ingersoll-Rand Co., 11 Broadway, New York City, which has some novel features. The valve chamber is independent of the piston chamber which permits of the use of pistons of different lengths without the liability of valve breakages, so common in pneumatic hammers where the piston travels through the valve, or where the construction is such that the valve travels in line with the piston and is shifted by the piston compression. The grip-handle is of liberal size, and has a single lever throttle with a long bearing. The



Ingersoll-Rand "Little David" Riveting Hammer

handle is attached to the cylinder by means of two bolts which are parallel to the cylinder on the sides. This insures perfect locking of the handle to the cylinder and precludes the necessity of using a vise or other mechanical device for holding the tool when taking it apart. This feature is especially convenient for structural iron workers who are not always equipped with the proper facilities for repairing tools. The hammer can be taken apart on the floor or the bench, and the only appliance necessary is a wrench for removing the nuts on the bolts. There is only one large port in the cylinder, which is equal in volume to the usual multiple port construction, but eliminates the liability of clogging.

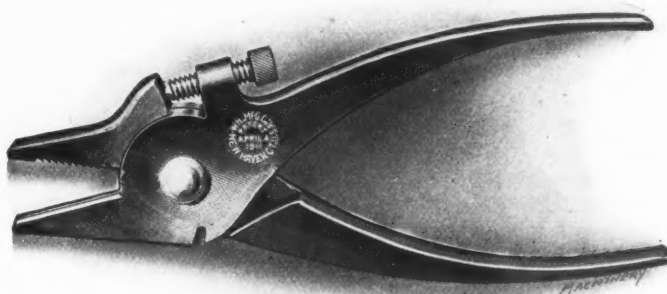
The hammer is shorter in length than other makes with a like stroke. It is light in weight, easy to handle, and has a very sensitive throttle control, making it specially suitable for drift pin work. The hammer is made in two sizes. The No. 60 has a 6-inch stroke and a capacity for driving rivets up to  $\frac{7}{8}$  inch in diameter. The No. 80 has an 8-inch stroke and is suitable for driving rivets up to  $1\frac{1}{4}$  inch in diameter. The cylinder and handle are drop-forged, and all wearing parts are hardened. Another important feature is the sand blast finish on both the cylinder and handle which overcomes the hand slippages so frequent with hammers with a polished surface.

### WEST HAVEN PLIER-WRENCH

The illustration shows a patented plier-wrench which has been placed on the market by the West Haven Mfg. Co., New

Haven, Conn. This tool is made of drop-forged, tempered steel and has a set-screw on the arm by which the jaws may be set to any size within the range of the tool. By this means, all the back strain of the plier arms is taken by the set-screw. When used in this way, the tool constitutes a convenient form of wrench which will grip and release round material, working like a ratchet.

When it is required to use the tool as an ordinary pair of pliers, the set-screw is turned back where it is entirely out of the way. As part of the face of one jaw is milled crosswise,



West Haven Plier-wrench for use as a Wrench or Pliers

and the other is smooth with a groove milled lengthwise, this adapts the pliers for securing a firm grip on the end of a wire.

This plier-wrench is especially useful in machine shops and garages, and it also constitutes an all-around handy tool for plumbers, electricians, and metal workers. It is made in two sizes, and either nickel-plated or finished black. The No. 8 tool is  $6\frac{1}{2}$  inches long and has jaws which open 1 inch. The No. 18 tool is  $8\frac{1}{2}$  inches long and the jaws open  $1\frac{1}{2}$  inch.

### MUMMERT-DIXON OIL-STONE GRINDER

Mummert-Dixon Co., Hanover, Pa., has brought out an oil-stone grinder which is adapted for use in machine shops—particularly in the tool-room. Two oil-stone wheels are mounted on the front arbor of this machine, one wheel being coarse-grained and the other fine. There is a tool-rest at the front of each wheel, which can be easily adjusted to any desired angle and held in that position by a convenient locking device. The machine is particularly adapted for grinding



Mummert-Dixon Grinder with Oil-stone Wheels

lathe and planer tools and machine scrapers. For this purpose the coarse oil-stone wheel is used for the preliminary part of the grinding operation, and the fine wheel produces the final edge.

Kerosene oil is used on these wheels, which prevents any

tendency for them to "glaze," and also protects the tools from undue heating during the grinding operation. The oil is delivered to the stones by a small rotary pump which draws it from a reservoir in the base of the machine. The oil-stone wheels are cup-shaped and the oil is directed against the inside of the wheel; it then penetrates through the pores of the stone to the outside. When the wheels have become saturated they require very little oil to keep them in working order. Guards are used to prevent the oil from being thrown off the wheels and any surplus oil is caught in the pan and returned to the reservoir.

A ring emery wheel is carried by an arbor at the back of the grinder, and a slide table is provided at the side of this wheel for holding the work. The slide is provided with micrometer adjustments and the slide table may be adjusted to any angle. A great variety of work, such as hand filing operations, can be handled by this part of the machine much more quickly and accurately than they could by hand. A rest is provided so that the periphery of the wheel can also be used for grinding. This ring wheel runs at four times the speed of the oil-stone wheels. The machine may be adapted for motor drive, in which case a motor is placed in the base and connected to the pulley by a belt.

### U. S. ELECTRIC GRINDER

The motor-driven grinding machine illustrated herewith is a product of the U. S. Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. This tool is made with either direct- or alternating-current motor drive. The alternating-current grinder is driven by a motor adapted for operation on



Electric Grinder made by the United States Electrical Tool Co.

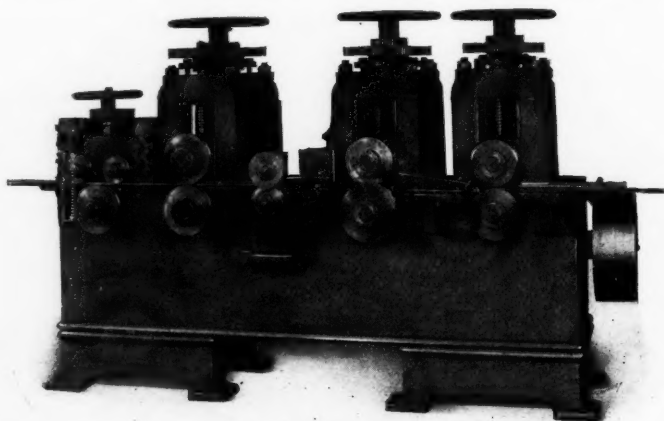
220-440 volt circuits of twenty-five- or sixty-cycle, two- or three-phase. The machine driven by direct-current motor is adapted for 110-220 volt circuits.

The advantage of the direct motor drive on this tool lies in the fact that it is easily installed and may be located in any position in the shop, where it is most convenient. The absence of belts, shafts, and shaft-hangers provides clearance for overhead cranes, and also does away with the obstruction of light in the shop. The bearings of a direct-connected grinder are also relieved from the strain due to belt pull, which increases the efficiency of operation and reduces wear in the bearings.

Referring to the illustration it will be seen that the motor is completely enclosed and equipped with a heavy shaft and large dustproof bearings which insure reliable operation and minimum wear. The bearings are of the ring-oiled type. The design of the motor is such that no starting box is required. The machines are built with motors of three and five horsepower. The three-horsepower machine operates at 1800 revolutions per minute and is equipped with 12 by 2 inch emery wheels. This machine is 36 inches in height from the floor to the center of the arbor, and has a weight of 575 pounds. The 5-horsepower machine operates at 1120 revolutions per minute and is equipped with emery wheels 18 by 3 inches in size. The machine is 36 inches in height from the floor to the center of the arbor and has a weight of 875 pounds.

### ETNA TUBE ROLLING MACHINE

The Etna Machine Co., Toledo, Ohio, has recently placed on the market a tube-forming machine which is used for rolling tubes into shape ready to have the joints brazed. The illustration shows the machine with a tube in course of production between the rolls. It will be seen that the ribbon



Etna Rolling Machine for forming Butt-end Tubing

stock, from which the tube is made, is fed between the forming rolls from right to left. In passing between the successive rolls, the stock is formed to the required shape, the ends abutting against one another. The machine is only intended for the production of butt-end tubing.

### NIAGARA CURVING AND FORMING MACHINE

The illustrations show a forming and curving machine for forming corrugated material, for culverts, sewers, etc., which was recently built by the Niagara Machine & Tool Works, Buffalo, N. Y. In designing this machine the intention was

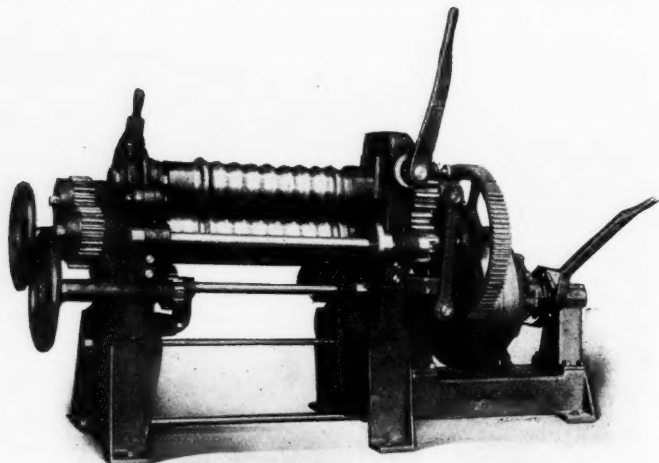


Fig. 1. Forming and Curving Machine for making Corrugated Cylinders to produce a substantial and rigid construction, and at the same time provide all conveniences for adjusting and operating to obtain a maximum output. The machine will handle work as heavy as No. 10 gage standard galvanized sheets;

and it will not only curve them, but reshape the ends at the same time to make the different sections interlocking.

The arrangement of the rolls is shown in Fig. 2. They are forged from high-carbon steel, and made in one piece with the exception of the forming collars on the ends, which are removable. The two front rolls, as well as the rear roll, are driven by pinions and connecting gears made of steel, which have teeth cut from the solid. The lower and the rear roll can be raised and lowered by a handwheel on the left-hand side of the machine, and the upper roll can be raised by a lever on the right-hand side, to remove formed cylinders. The machine is double back-gear-

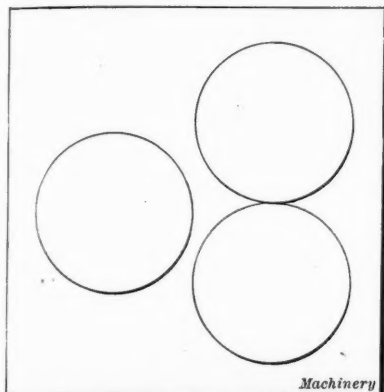
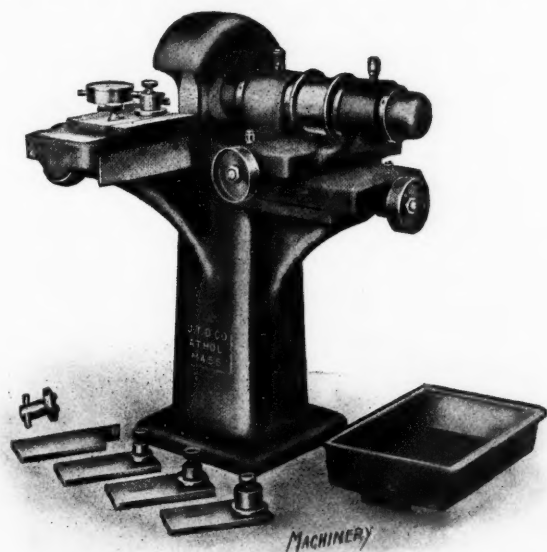


Fig. 2. Diagram showing Arrangement of the Rolls

the motion being controlled by a hand lever operating a powerful friction clutch. All bearings are bronze bushed. The outside diameter of the rolls is  $7\frac{1}{2}$  inches, and the diameter in the bearings  $3\frac{1}{2}$  inches. The machine weighs 4500 pounds.

### UNION TWIST DRILL CO.'S FORMED CUTTER GRINDER

The machine shown in the accompanying illustration is a recent product of the Union Twist Drill Co., Athol, Mass., and is known as the No. 1 formed cutter grinder. This machine is designed for grinding formed cutters radially so that the cutter runs true and each tooth does its proper share of the work. Referring to the illustration, the cutter which is to be ground is mounted on the vertical arbor shown on the table of the machine adjacent to the wheel. To the left of the cutter there is an indicator which comes in contact with the relieved face of the tooth. When the radial face of one



Machine for grinding Radial Faces of Cutter Teeth

of the teeth has been ground, the reading of this indicator is noted. The work is then rotated to bring the next tooth into position for grinding, the cutter being adjusted to obtain a corresponding reading of the indicator to that at which the preceding tooth was ground. By this means the work is indexed to the required position. The successive teeth of the cutter are indexed and ground by this means. A small hand-wheel will be seen on the slide, upon which the work is mounted; this wheel provides for adjusting the slide in the desired position.

It will be seen that two thumb-wheels are provided for securing longitudinal and transverse travel of the wheel. When

the work has been indexed, the thumb-wheel for operating the transverse movement is brought into action and traverses the wheel up to the work. The longitudinal traverse wheel is used for truing the wheel. For this purpose, a diamond is mounted inside the wheel guard in line with the axis of the arbor upon which the work is mounted. When it is desired to true the wheel it is merely necessary to traverse it up against the diamond which trues the face that grinds the radial surface of the tooth.

The countershaft used with this machine has tight and loose pulleys six inches in diameter by  $1\frac{1}{2}$  inch face, and runs at a speed of 450 revolutions per minute. The grinding wheel used is 5 inches in diameter and a dust pan is provided for receiving the dust from the wheel when the machine is not connected to an exhaust fan. Work arbors are provided for carrying cutters having holes  $\frac{3}{8}$ ,  $\frac{1}{2}$  and  $\frac{5}{8}$  inch in diameter. The regular equipment of the machine includes a diamond for truing the wheel and a gage for setting the work in position for grinding. The net weight of the machine is 65 pounds.

### S. K. F. BALL-BEARING HANGERS

The S. K. F. Ball Bearing Co., 50 Church St., New York City, is now placing on the market a new type of ball bearing line-shaft hanger of strong and simple design. The box containing the self-aligning ball bearing is suspended in the hanger frame on four adjusting screws, providing for lateral and vertical adjustments. The boxes are made in a single piece,

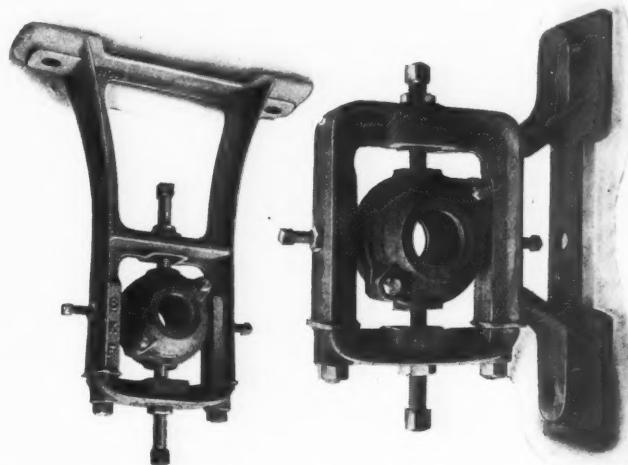


Fig. 1. Hanger designed for Attachment to Ceiling

Fig. 2. Hanger for Attachment to Wall or a Post

accurately machined for the reception of the ball bearings and provided with a suitable face cap; the assembled box forms a large lubricant chamber with grooves adjacent to the shaft for the retention of the lubricant. The ball bearings themselves provide the alignment feature within the hanger box. The outer race is ground in the form of a sphere whose center

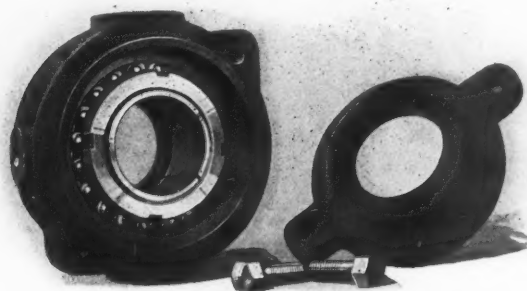


Fig. 3. S. K. F. Bearing used in Hangers

is at the center of rotation of the bearing, and the inner race and double row of balls act within this spherical race in a manner similar to the familiar ball and socket joint.

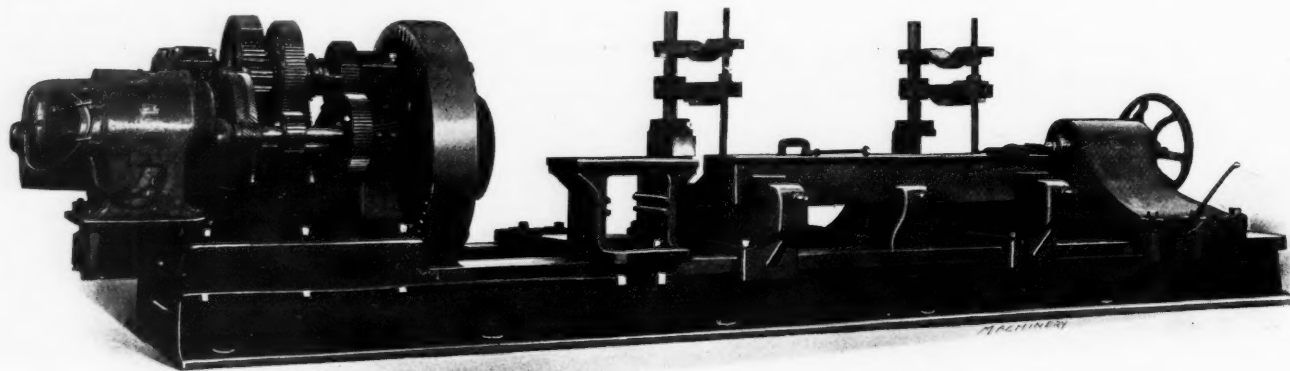
In case a shaft springs under load, the bearings adjust themselves to the deflection, at the same time maintaining a uniform circle of rotation for the balls. The bearing is of the familiar S. K. F. self-aligning type fitted with an adapter.

This consists of a taper sleeve and locking nut which secures the bearing rigidly in position on the shaft.

A series of careful experiments has established the fact that the amount of power that may be saved by operating lineshafts on ball bearings will range from sixty per cent to ninety per cent of the power required to drive the shafting alone. The various causes of friction in lineshafting are: misalignment, lack of proper lubrication, insufficient protection of the bearings against the intrusion of grit or shop dust and heavy belt tension on the driving or service pulleys. While ordinary lineshafts operate at speeds anywhere from 100 to 300 R. P. M. and are usually limited to these speeds, shafts running in ball bearing hangers may safely be run as high as 600 to 1000

ways, and has a total weight of 84,000 pounds.

The distinctive features of the design of this lathe may be briefly outlined as follows: There are no over-hanging gears, all of the wheels being between the two bearings on the headstock. All of the shafts can be lifted out independently without disturbing the others. The heavy driving gear for the faceplate pinion is located next to the front bearing of the headstock, and this design eliminates any spring which might be produced in this shaft. The main pinion is so located that the pressure on the shaft is down and not against the cap. All of the gears are of steel and have cut teeth, with the exception of the faceplate gear which is of air furnace iron. The motor gears are of the double spiral type. An iron gear guard,



Garrison Lathe designed for Use in Steel Foundries and Roll Shops

R. P. M. without danger of heating, and with a considerable reduction of pulley sizes, shaft sizes and weights, and a consequent reduction of belt sizes and costs.

Ball bearing hangers also reduce the lubrication required. The reason for this is that ball bearings require lubrication only at infrequent intervals, and the construction of the bearing boxes in the S. K. F. hanger frames is such that the leakage of lubricant is done away with. This factor, besides effecting a saving in the amount of lubrication used, introduces a large saving in the maintenance costs.

#### GARRISON LATHE FOR TURNING STEEL CASTINGS

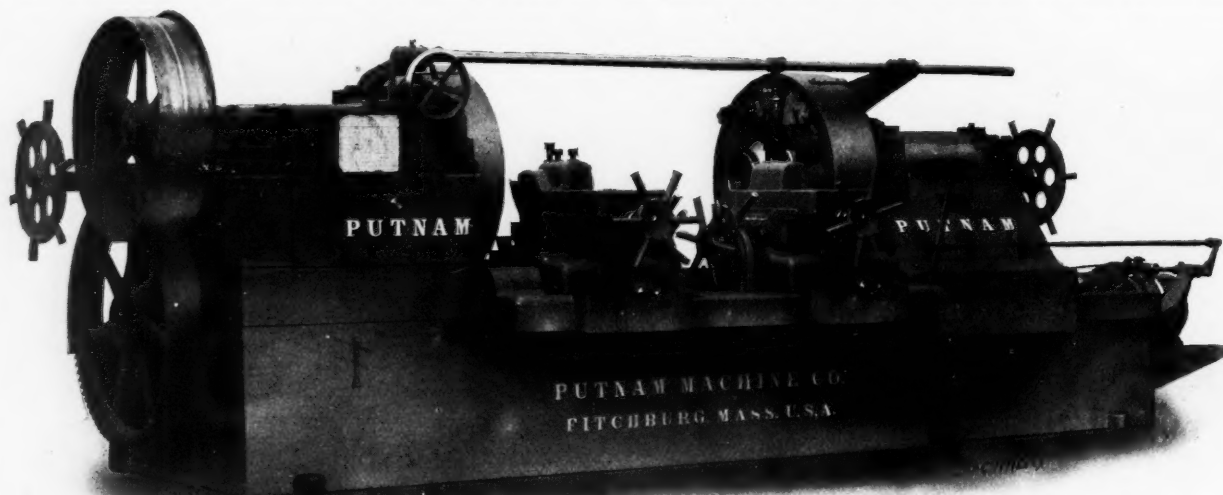
The lathe shown in the accompanying illustration was designed for use in steel foundries and roll shops, where the

which is not shown in the illustration, completely covers all of the gears. This guard can be quickly removed when it is necessary.

The chief dimensions of this machine are as follows: Length of bed, 30 feet; maximum distance between centers, 21 feet; number of gear reductions from the motor to the faceplate, 5; total gear reduction (not including motor gears) 1 to 220; motor horsepower (continuous rating) 30 to 40; motor speed 550 to 1100 revolutions per minute.

#### PUTNAM FORTY-TWO INCH COACH-WHEEL LATHE

The 42-inch lathe illustrated in this connection is a recent product of the Putnam Machine Co., Fitchburg, Mass. This machine has been designed for turning coach-wheels, and with



Putnam Lathe designed for turning Coach-wheels

greater part of the work consists of turning large steel rolls and pinions. This is a particularly severe class of service and the machine which can handle it satisfactorily must be of massive construction. With these requirements in view, the A. Garrison Foundry Co., Pittsburg, Pa., has brought out a lathe in which the bed is made of the double box type and strongly ribbed to secure the required rigidity. The machine swings 50 inches over the necking rest and 62 inches over the

a view of adapting it to the severity of this class of service the construction has been made particularly massive. This fact will be readily appreciated when it is known that the weight of the machine is 80,000 pounds. Referring to the illustration it will be seen that the machine is equipped with a single-pulley drive, and six mechanical speed changes are provided. The lathe is adapted for either motor or belt drive.

Among the features of this lathe the following may be men-

tioned. The journal boxes supporting the main driving shaft are self-oiling. Flat chains are used to run over the shaft and the supply of lubricant which is carried up from the reservoir in this way insures keeping the bearings flooded. The journal boxes are piped on the outside of the machine for replenishing the oil supply. The Putnam patented non-slip equalizing driving dog is used on this machine, as well as on the double-headed driving wheel lathe of this company's manufacture. This dog is positive in action and each dog exerts the same driving force, thereby avoiding the danger of springing the tire more at one point than at another. This dog automatically adjusts itself to the load; and its driving force is not fixed but is always relative to and in excess of the resistance. The only adjustments which need to be made on this dog are to release it from the latched position after the wheels have been mounted in the lathe. The customary T-bolts and straps are furnished with the dogs, but the tires of many classes of wheels can be turned without them.

The Putnam combination tool-slide which is used on this lathe adds considerably to the efficiency of its operation. A tire may be finished in two operations and without requiring a change of tools except in cases where a tool-failure occurs. In such a case the damaged tool may usually be replaced while the other tool is working at its normal capacity. One roughing and one forming tool are mounted side by side in this carriage and either tool is readily detachable for the insertion of another tool in its place. The movement of the tailstock is provided for by a simple motor-driven mechanism. The tailstock is moved along the bed by a massive screw and nut and this movement is stopped when the wheels are in position, by an adjustable brake band which comes into action and allows the drum to slip.

### LANGELIER SWAGING MACHINE FOR WIRE SPOKES

An improved type of automatic swaging machine designed and built by the Langelier Mfg. Co., Providence, R. I., for swaging wire automobile wheel spokes is shown in Fig. 1. It takes the wire from the coil, straightens it before entering the machine, swages the spokes between butts and cuts them off to length after swaging, all operations being entirely auto-

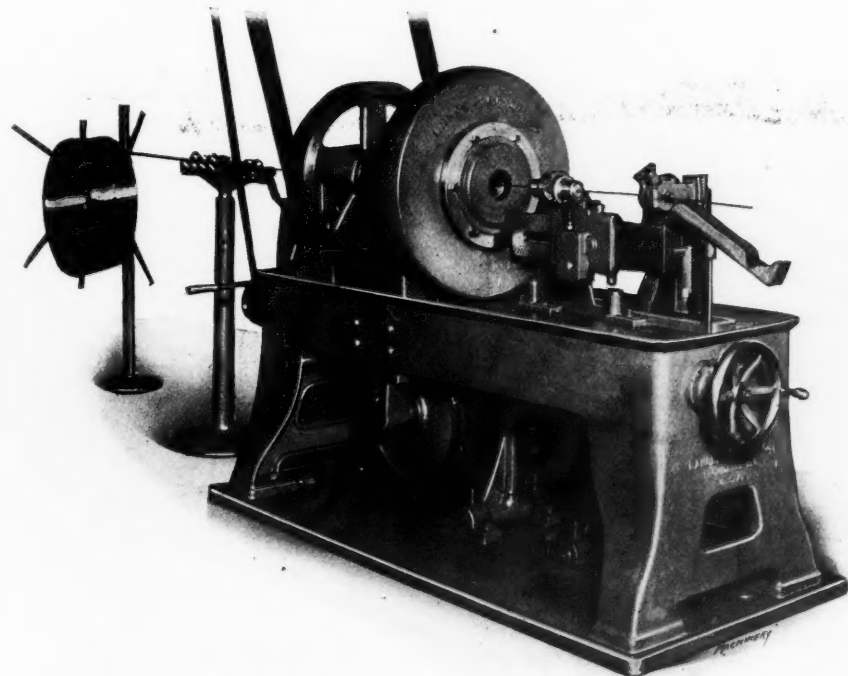


Fig. 1. Langelier Swaging Machine for making Wire Spokes for Automobile Wheels

matic and absolutely without waste or manual handling. The relative lengths of blank and finished spoke are shown in Fig. 2.

This machine has a very high output. On ordinary automobile wire wheel spokes, the output is as high as three spokes a minute, all straightened, swaged and cut off. This is obtained by eliminating all time losses between operations.

While one spoke is being swaged, a finished spoke is being cut off. The coil of wire is supported on a reel resting on the floor (shown at the extreme left in the illustration) from which it unwinds as the wire is drawn through the straightener on its way to the swaging machine. This straightener is an improved design of the rotary type of wire straighteners built by this company. It has off-set steel eyelets mounted on ball bearings in suitable holders, so designed that the off-set eyelets do not bear in an unyielding manner against the passing wire but revolve without marring its finish. Once properly adjusted to the correct off-set, these eyelets very seldom require adjustment, as no perceptible wear occurs until they have been long in use.

The wire enters the special swaging machine through the rear end of the hollow spindle carrying the dies, and as it is

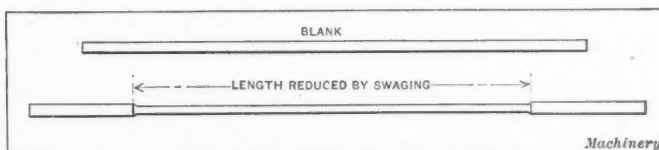


Fig. 2. Diagram showing Blank and Finished Spoke

drawn through, these swaging dies close automatically over the wire, after allowing the portion forming the butt to pass out of them. A number of sharp blows are applied on the stock simultaneously from diametrically opposite directions, reducing it rapidly and giving it a sort of "hammer temper," for the distance between the butts. The dies then open automatically, allowing the portion of wire forming the opposite butt to pass out of the machine unswaged.

The outward travel of a saddle with the chuck mounted on a horizontal slide in front of the machine head draws the wire through. This saddle is provided with a rack, seen projecting at the end of the slide in Fig. 1, in which an oscillating segment gear meshes. This gear is set in motion by a face cam and roller underneath the bed of the machine. The connection between the segment and the cam roll lever is obtained by means of a special form of link having a right- and left-hand nut (readily reached and locked from the rear), which upon being adjusted vertically, varies the centers of the link pins. This increases or decreases the arc of travel of the segment gear, and varies the travel of the saddle on the horizontal slide above the bed, thus producing spokes of different lengths and with different swaged portions between the butts. The wire gripping chuck, carried by the saddle, closes on the wire for the outward or drawing stroke and releases it at the end of the stroke, the wire being entirely clear during the return of the chuck to its starting position for drawing out the next spoke. The automatic operation of the chuck is obtained through the up or down action of a wedge, actuated by the saddle as it reaches its extreme points of travel. At the end of this outward stroke, the wire is gripped firmly in the cutting-off attachment while the saddle returns rapidly to take the next spoke forward and the finished swaged spoke is cut off just before the next drawing stroke begins.

The cutting-off attachment consists of two hardened and ground steel bushings, whose two cutting faces are in close contact and slide past each other rapidly at the proper time. The swaged spoke is cut off with an almost perfect shear, and without any deformation of the wire, the ends being sharp and square with the wire. Forced oil lubrication to all running parts and to the dies is maintained by an automatic oil feed pump. Other types of wire feeds besides that described are also put on to suit different maker's spokes, and the machine is built for either belt or motor drive. The net weight is about 5500 pounds and the floor space occupied about 2 by 6 feet.

# Have You a Job of Grinding

If you have, a suitable machine for the work is the

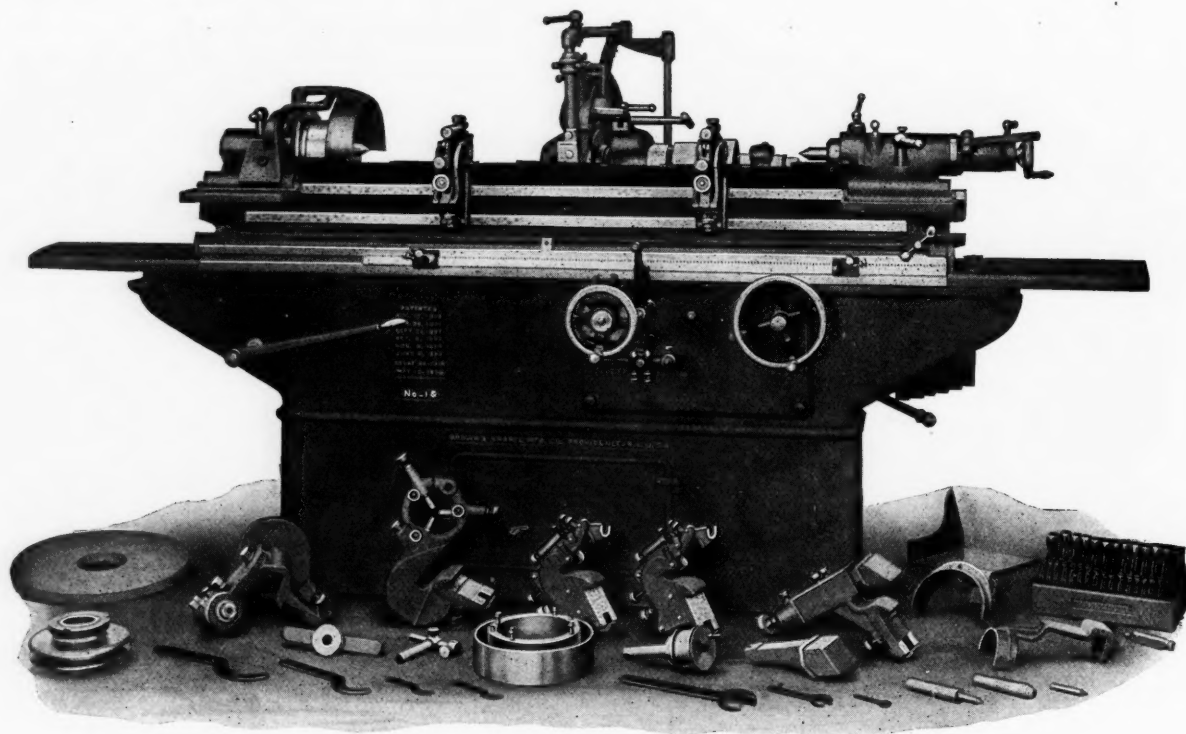
## No. 14 Plain Grinding Machine

This machine swings 10" diameter and takes 48" length.

It is rigid in design and all alignments are correct—features that insure accurate work under heavy manufacturing cuts.

Rapid production is possible due to two important mechanisms—the automatic cross feed and universal back rests. By means of these work is quickly ground to accurate duplicate size with minimum attention from operator.

The machine is convenient for the operator. All levers and hand-wheels are within easy reach from the front. Work centers are at a convenient height.

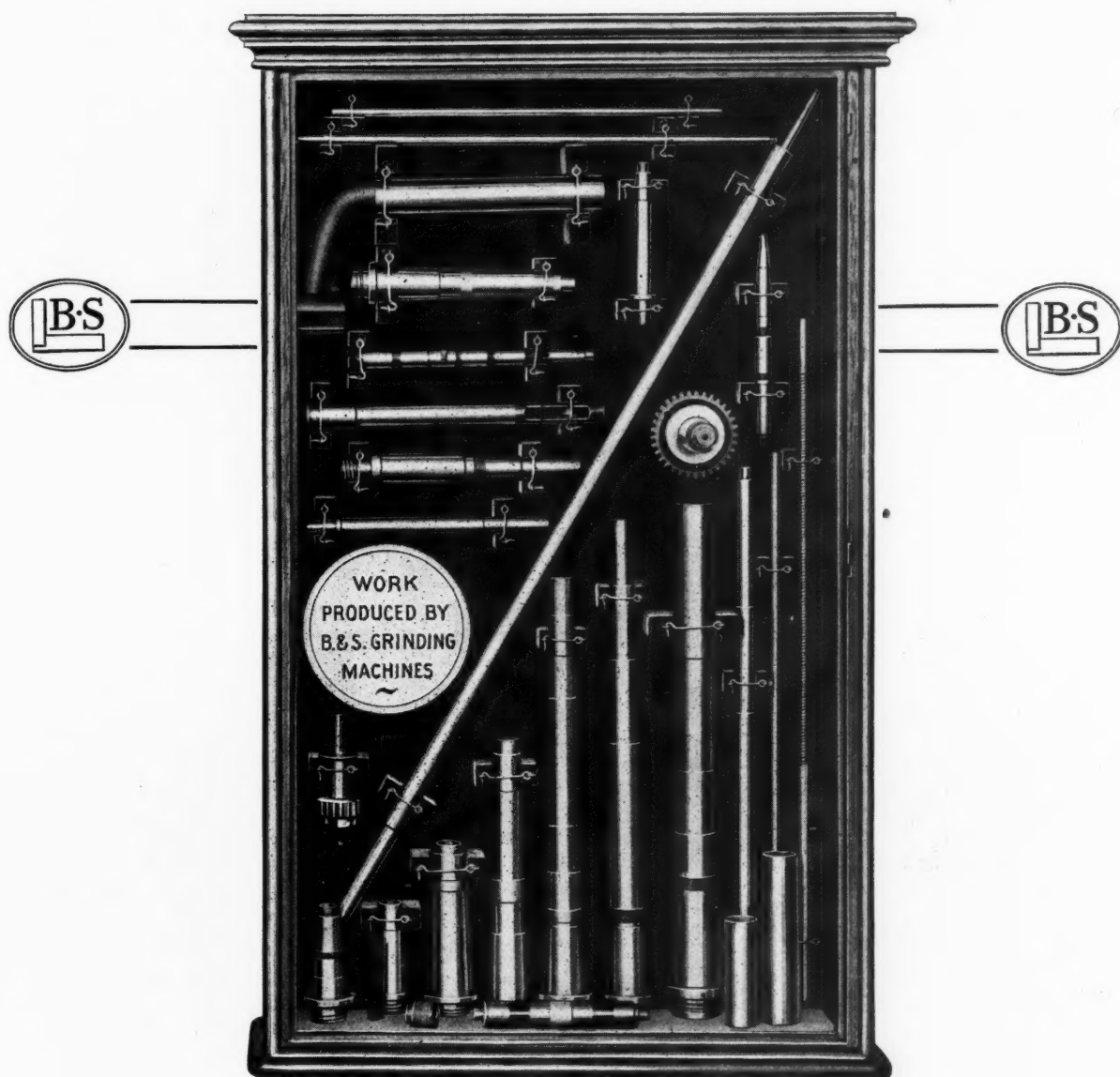


## Brown & Sharpe Mfg. Co.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-30 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429 University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O.; Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

# Similar to Any in This Case?



*Look over the pieces carefully.* There are long slender shafts requiring careful support, long and short pieces of large diameter on which heavy cuts are taken, taper bearings on spindles, irregular shaped work such as shown near top of case, etc.

Note composite piece at bottom of case, consisting of hard steel, hard rubber, cast iron, aluminum, bronze, mica and soft steel. All ground equally well on the No. 14 machine.

## Providence, R. I., U. S. A.

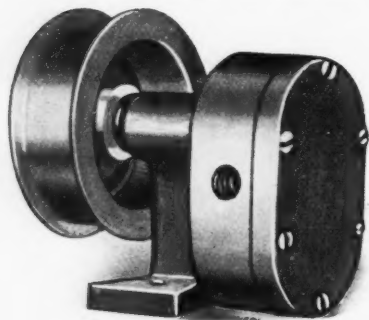
Canadian: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

Foreign: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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### BICKFORD GEARED OIL PUMP

This pump has been brought out by the Bickford Machine Co., Greenfield, Mass., to meet the demand for an inexpensive



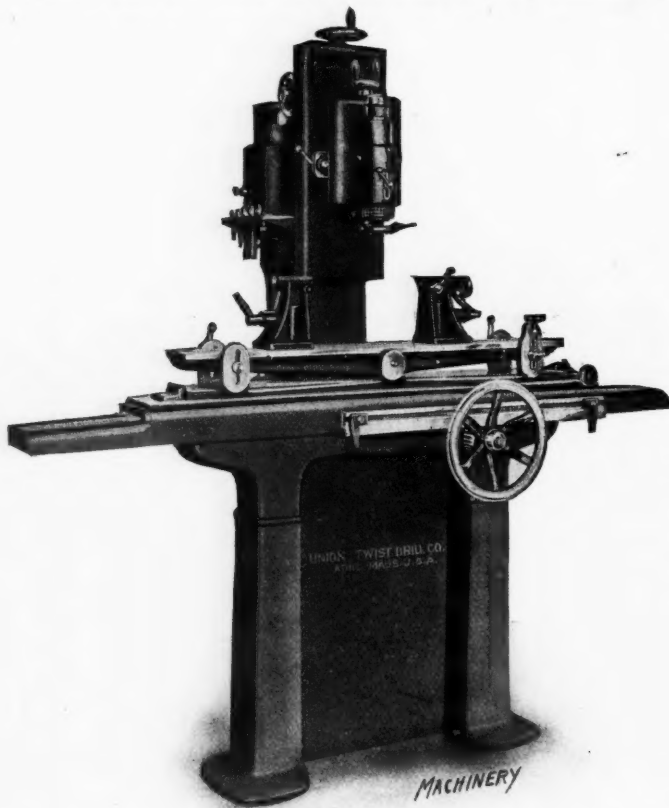
Bickford Geared Oil Pump

device for supplying lubricant to cutting tools. The pump is of the regulation geared type, its main feature being the compactness of its design, together with the use of a special form of internal stuffing box which allows the main bearing to extend right through the pulley. It is tapped to receive a  $\frac{3}{8}$ -inch pipe and will deliver oil or water at an equal rate, the capacity being 12 quarts per minute when the pump is running at 500 revolutions per minute.

### CUTTER AND REAMER GRINDER

The Union Twist Drill Co., Athol, Mass., has recently placed on the market the cutter and reamer grinder shown in the accompanying illustration. This machine is designed for grinding straight or spiral milling cutters, face mills, end mills and straight or taper reamers. Suitable fixtures can be furnished for use in connection with this machine, which adapt it for sharpening face mills and side teeth of side mills; a fixture can also be supplied which enables the machine to grind end teeth of end mills.

The machine has a capacity for grinding cutters up to 12 inches in diameter on centers, or reamers up to 24 inches in length. The cup form of wheel used on this machine is



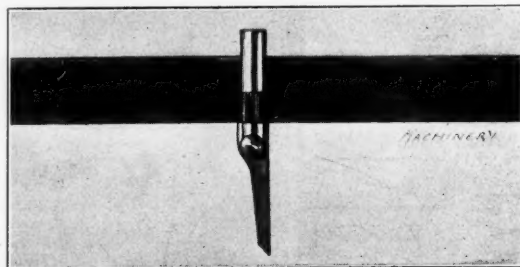
Union Twist Drill Co.'s Cutter and Reamer Grinder

mounted on the vertical spindle shown in the illustration. This spindle is of hardened and ground steel, and runs in bronze boxes which are provided with means for making adjustment for wear. The cup form of wheel used gives a flat clearance and a stronger cutting edge than that resulting from the use of a disk wheel. The countershaft which is used in connection with this machine has tight and loose pulleys six inches in diameter by two inches face and is intended to be operated at 700 R. P. M. The machine occupies a floor space

of 35 by 96½ inches. The regular equipment includes a countershaft, wrenches and an emery wheel. The net weight of the machine is about 1500 pounds.

### ALVAN HEIGHT GAGE

The illustration shows an attachment for a combination square which adapts this type of tool for use as a height gage. This attachment is a product of the Alvan Mfg. Co., 306 14th Ave., Newark, N. J. It consists of a hardened and ground jaw or blade which is secured to the scale of the combination square by an eccentrically located taper locking stud which is carried by a semicircular saddle piece. In adjusting the blade of the height gage attachment to any required position, the stud is partially loosened. When the saddle piece is secured in this way, a steady movement can be secured which



Alvan Height Gage Attachment for a Combination Square

enables the attachment to be brought to exactly the required position without delay. Ample compensation is provided for any variation in the width of the blade of the square on which the attachment is used.

When this attachment is used as a height gage for testing and gaging surfaces or scribing lines, the stock of the combination square constitutes the base of the gage. Used in this way, the attachment adapts an ordinary combination square for such work as laying out, scribing lines, transferring dimensions, testing and gaging surfaces, etc., on pieces set on a surface plate, planer, shaper or milling machine. A pair of these attachments used in conjunction with the square stock still further increases the scope and usefulness of the tool.

Where two of these attachments are mounted on the blade of a combination square, they form a beam caliper and can be used for making either inside or outside measurements. In laying out from a given edge or shoulder on surface work, this attachment is of particular value.

### BICKFORD BENCH GRINDER

This small combination disk and wheel bench grinder was designed by the Bickford Machine Co., Greenfield, Mass., to meet the requirements of small shops that could not afford a larger machine. It carries a 9-inch disk-wheel at one end of

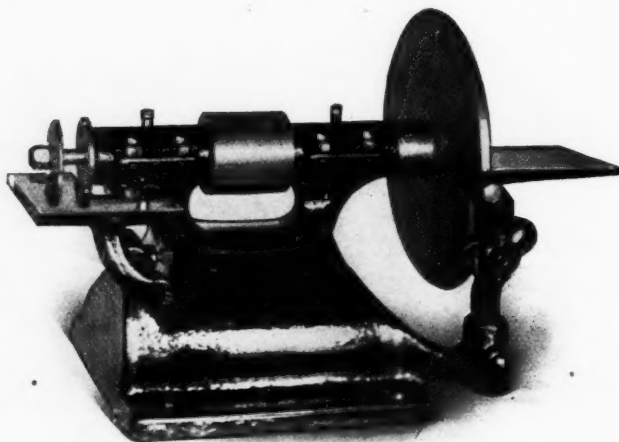
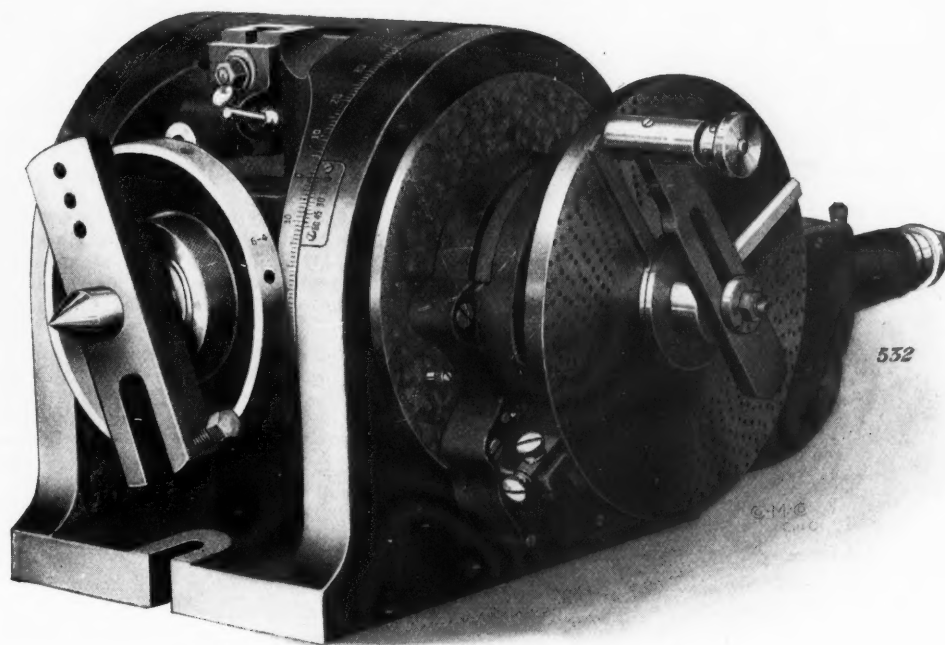


Fig. 1. Bickford Combination Disk and Wheel Bench Grinder

the spindle and any wheel at the opposite end having a  $\frac{1}{2}$ -inch hole and a diameter up to 8 inches. A single flat rest is provided for the disk-wheel which is adjustable so that work may be ground either square or beveled. A plain rest is provided for the wheel, which is set  $\frac{1}{4}$  inch below the center of the

## The Dividing Head is the Most Important Feature of a Universal Tool Room Milling Machine



All of our Universal Millers, both the Cone-driven type and the High Power Single Pulley Drive Machines are equipped with our Remarkably Rigid Universal Dividing Head.

Our design is simple and of proportions commensurate with the capacity of the High Power Machines.

For example—on a 12-inch Head the trunnions on which the spindle swings when setting for angular work, are  $8\frac{1}{2}$ " diameter; the spindle is  $3\frac{1}{2}$ " diameter in the front bearing.

There is a Front Index Plate for Direct Indexing any number that will divide evenly into 24, 30 or 36.

This is especially handy for indexing low numbers as when milling reamers, taps, etc.

The Direct Index is always ready for immediate use because the change from Universal Indexing to Direct and back again when the job is finished, is made in a few seconds without loosening anything or disturbing any adjustments.

The Side Index Plate is 8 13-16" in diameter. It will index all numbers to 60, all even and those divisible by 5 to 120, and meets all usual requirements to 400.

And for the occasional job of Indexing High Odd Numbers, our High Number Indexing Attachment enables you to get the division you want, by Simple Indexing from plates without compounding or the use of special gearing.

This method of Indexing High Numbers has the further advantage of being applicable to angular work and such large work that can only be done with the Dividing Head Spindle in a vertical position.

**The Cincinnati Milling Machine Company**  
CINCINNATI, OHIO, U. S. A.

spindle and arranged to support work held on either side of the wheel. This arrangement makes a useful combination of disk and tool grinder for the tool-room or jobbing shop. The spindle is  $\frac{3}{4}$  inch in diameter and runs in ring oiling adjustable bearings; it is driven by a  $2\frac{1}{2}$ -inch belt.

A special countershaft has been designed for use with this machine, which is operated by a pull cord. A disk (not shown) is mounted beside the large disk on the countershaft and



Fig. 2. Bickford Bench Grinder and Countershaft used to drive it

operates it by means of four teeth on each disk. The coil spring mounted on the rod carrying the belt loop keeps an arm on this rod in contact with a lug on the larger disk. The arrangement is such that  $\frac{1}{4}$  revolution of the disk will shift the belt either off or on the driving pulley. A tension spring returns the smaller disk to the original position, so that continuous pulls of the cord shift the belt back and forth. The tight and loose pulleys are 5 inches and  $4\frac{1}{2}$  inches in diameter and the driving pulley is 13 inches in diameter; all of the pulleys have a face width of  $2\frac{1}{2}$  inches.

### NEW MACHINERY AND TOOLS NOTES

**Pliers:** Utica Drop Forge & Tool Co., Utica, N. Y. These pliers are provided with a joint of the box type which affords support at each end of the hinge. One jaw is curved and the other flat and the pliers afford a parallel grip for all sizes of work within their range.

**Hardness Testing Machine:** Pittsburg Instrument & Machine Co., Pittsburg, Pa. A hardness testing machine which is based on the Brinell principle. The work is carried by a support, and a steel ball of 0.4 inch diameter is forced down upon it by a hydraulic press.

**Power Hammer:** Fairbanks Co., New York City. Leather straps have been eliminated from the design of this hammer, steel side arms and a spiral spring being employed to furnish the necessary elasticity. This hammer is built in two styles for either belt or direct-connected electric motor drive.

**Tool-holder:** Ready Tool Co., 654 Main St., Bridgeport, Conn. The important feature of the design of this tool-holder consists of a half round section of tool steel which is electrically welded to the body of the tool-holder and forms a bearing for the cutter. The body of the tool-holder is made of drop-forged chrome-nickel steel.

**Small Grinding Machine:** Ransom Mfg. Co., Oshkosh, Wis. Four sizes of small grinding machines which are made to carry wheels 8 by 1, 10 by  $1\frac{1}{2}$ , 12 by 2, and 14 by  $2\frac{1}{2}$  inches in size. These machines can be equipped with wheel guards which may be removed when it is desired to use buffing wheels on the machines.

**Hydraulic Pit Jack:** Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic pit jack having a capacity for lifting loads up to 10 tons and a rise of 103 inches. This jack

is designed for such work as raising locomotive wheels and axles into position or lowering them when the axles are being removed from a locomotive.

**Broaching Machine:** J. N. Lapointe Co., New London, Conn. The machine is driven by a pulley 22 inches in diameter by  $4\frac{1}{2}$  inches face, and the driving screw is  $3\frac{3}{4}$  inches in diameter by 1 inch pitch. Two geared speeds are provided by gears which run in an oil bath. Provision is made at the front end of the machine for attaching special fixtures.

**Automatic Pinion Making Machine:** Sloan & Chace Mfg. Co., Ltd., Newark, N. J. A machine designed for making pinions for watches, electric meters and similar mechanisms. The pinions are made direct from bar stock and the machine is able to make a complete pinion with a double cut, consisting of a roughing and a finishing cut across the teeth.

**Hand Lathe:** Grant Automatic Machine Co., Detroit, Mich. A hand lathe with the body and headstock cast in one piece and the spindle bearing lined with babbitt. The tailstock has both lever and screw feed, and the former may be instantly disconnected when it is required to use the handwheel or screw. The rest is clamped to the body by a single motion.

**Keyless Drill Chuck:** Gronkvist Drill Chuck Co., 20 Morris St., Jersey City, N. J. A chuck which consists of a knurled operating sleeve and a threaded shank which is slotted to receive three tapered jaws. The angle on the outside of the jaws and on the inside of a taper sleeve within the operating sleeve corresponds, and by turning the operating sleeve, the taper sleeve is forced in on the jaws, thus securing a firm grip on the work.

**Three-spindle Cylinder Boring Machine:** Newton Machine Tool Works, Inc., Philadelphia, Pa. The machine is driven by a Westinghouse motor, providing spindle speeds of from 10.31 to 20.62 R. P. M. The drive to each spindle is through bronze spiral gears and a hardened steel worm. The main body of each spindle is 6 inches in diameter and the spindles run in bearings which are 29 inches in length.

**Flexible Shaft:** Plank Flexible Shaft Machine Co., Grand Rapids, Mich. A flexible shaft with a core made up of a number of small units. These units interlock in such a way that a continuous core can be assembled without the use of rivets or pins. This construction makes the units readily interchangeable for either varying the length of the shaft or for making repairs. The core is protected in the ordinary way by a spiral spring steel coil covered with leather.

**Plain Milling Machine:** R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. This machine consists of a heavy-duty cone-type miller which has been manufactured by this company, in which an important improvement has been made by the application of quick traverse to the table. This effects a considerable reduction in the time ordinarily lost in non-productive motion. The quick traverse mechanism is an integral part of the machine and is built into the feed mechanism.

**Fastening Bolt for Masonry:** Paine Co., Corn Exchange Bldg., Chicago, Ill. A bolt adapted for fastening machinery to masonry or concrete. For this purpose a bolt of the usual style is provided with a split sleeve and a conical-ended sleeve between the nut and the head of the bolt. When the nut is screwed down it pushes the conical point of the upper sleeve into the split end of the lower sleeve, and in this way the split sleeve is expanded and secures a firm grip on the hole which has been drilled in the masonry.

**Six-spindle Drilling Machine:** Moline Tool Co., Moline, Ill. A six-spindle drilling machine driven by the spiral gear arrangement which has been applied on the machines of this company's manufacture. The heads are arranged for clamping in groups and means are provided for traversing the groups as required. This machine was especially designed for such operations as drilling railway frogs and switches, the work being clamped to T-slots in a vertical faceplate on the lower part of the column of the machine.

**Large Compression Yoke Riveter:** Hanna Engineering Works, Chicago, Ill. A large compression yoke riveter built for the General Electric Co., Pittsfield, Mass. This tool is to be used for riveting transformer cases. The riveter weighs 56,000 pounds, has a reach of 168 inches, a gap of 12 inches and exerts a pressure of 100 tons on the riveter for a pressure of 100 pounds in the cylinder. The Vulcan Engineering Sales Co., Chicago, Ill., is agent for this riveter, as well as the other products of the Hanna Engineering Works.

### ANNUAL CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION

The fifteenth annual convention of the National Metal Trades Association was held in New York City, April 9-10 at the Hotel Astor, Mr. Henry D. Sharpe presiding. The program comprised the following reports and papers:

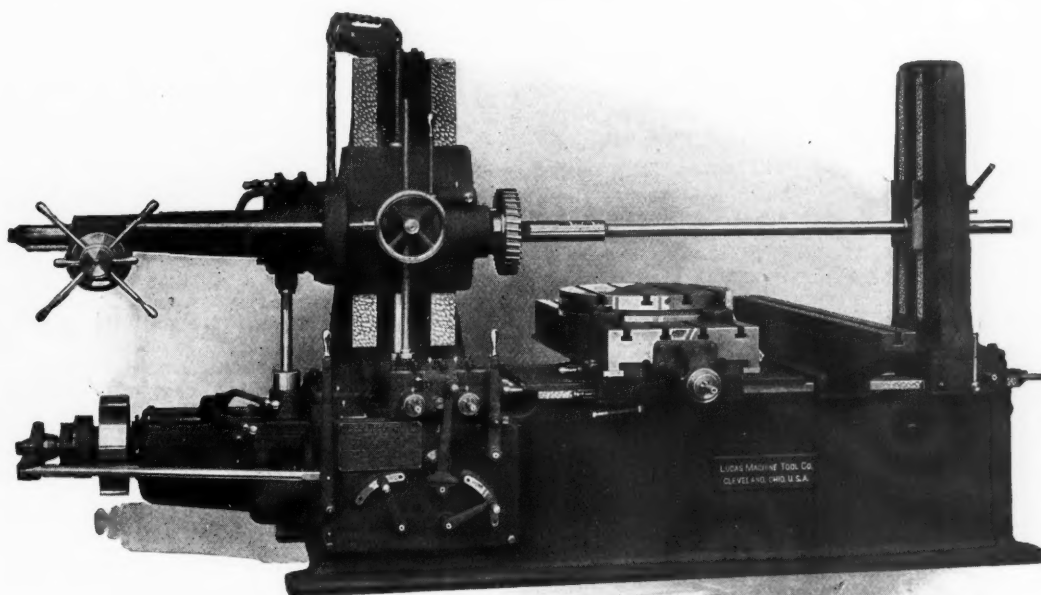
"Reports on Industrial Education," F. A. Geier, chairman;  
 "Apprenticeship," E. P. Bullard, Jr., chairman;  
 "Systematic Compensation for Industrial Accidents," Henry D. Sharpe, chairman;

We do not include a **LIABILITY INSURANCE POLICY** with  
the machine when we sell a

# LUCAS "PRECISION"

## BORING, DRILLING AND MILLING MACHINE

Because, WE DON'T HAVE TO



All the operating handles are so arranged with  
relation to each other that there is no probability  
of **INJURY TO THE OPERATOR** and  
he can't get in more than one feed at the  
same time, either.

**LUCAS MACHINE TOOL CO.,**



**CLEVELAND, O., U.S.A.**

AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst & Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

"Luck, Law and Industrial Accidents," by W. H. Doolittle, National Metal Trades Association's safety inspector;

"The Plea for Profit Sharing," by Maurice Barnett, of the Electro-Dynamic Co., New York City;

"Fire Prevention in Factories," by Lewis T. Bryant, Commissioner of Labor, State of New Jersey;

"Pension Plan for Employees," by William Lodge of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio;

"What's the Matter with the U. S. A.?", by Joseph W. Bryce of the *Square Deal Magazine*, Battle Creek, Mich.

The following officers were elected for the ensuing year: President W. A. Layman, Wagner Electric Mfg. Co., St. Louis, Mo. First vice-president, L. H. Kittredge, Peerless Motor Car Co., Cleveland, Ohio; Second vice-president, Herbert H. Rice, Waverly Co., Indianapolis, Ind.; Treasurer, F. C. Caldwell of H. W. Caldwell & Son Co., Chicago, Ill.

Mr. Robert Wuest, who has served the National Metal Trades Association so long and ably as its commissioner, has resigned on account of poor health and is succeeded by John D. Hibbard. The headquarters of the association will be removed from New England Building, Cleveland, Ohio, to the People's Gas Building, Michigan Ave., Chicago.

\* \* \*

## YALE & TOWNE NEW OFFICE BUILDING

Yale & Towne Mfg. Co. has removed its offices from 9 Murray St. to the new Yale & Towne building at 9 East 40th St., New York City, where a modern twelve-story building has been



New Yale & Towne Building

erected on a plot 50 by 100 feet. The company will occupy the entire building except three floors which will be rented. The new location was selected after a long and thorough investigation, as being the one best suited to meet the convenience of customers and to promote efficiency of management. It is in the center of the uptown section midway between the Grand Central and Pennsylvania railroad terminals in the heart of the hotel section and is easily accessible from all parts of the city.

The ground floor will be devoted to a series of exhibit rooms in which will be shown a large and effective display of locks and builders' hardware. The

basement will contain the city salesroom, a large stock-room, and the repair department. The executive offices and directors' room will be on the twelfth floor, and the remaining floors will be devoted to the offices of department managers, treasurer and the large clerical force required for the business.

\* \* \*

## PERSONALS

Francis Auberty, of Paris, France, who has been in this country for over two years studying conditions and methods of manufacture in the machine tool business, sailed for home April 17.

Henry Jungerman has been appointed railway representative of Tate-Jones & Co., Inc., Pittsburg, Pa. Mr. Jungerman was formerly with the motive power and construction department of the Harriman Lines.

William J. Alles, night superintendent of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has resigned to take a position as assistant to Mr. J. S. Haynes, manager Dodge Bros., Detroit, Mich., beginning May 1.

Arthur S. Day, formerly manager of the Philadelphia office of Hill, Clarke & Co., Inc., has since April 1 been connected with

the sales force of the Eveland Engineering & Mfg. Co., of Philadelphia, manufacturer of electric riveting machines.

Paul Lux of the Lux Model Works, Waterbury, Conn., has resigned his position as model maker of the Waterbury Clock Co. so that he may devote his entire time to the perfection of his line of special clock movements, spring motors, and other small gear mechanisms.

Oscar E. Perrigo, of Boston, Mass., delivered a lecture on the subject of rapid change gear devices before the Providence Mechanical Engineers' Association, Providence, R. I., March 25. As an introduction to the lecture, a brief history of the development of the lathe was given.

L. S. Starrett of the L. S. Starrett Co., Athol, Mass., received many congratulations April 25, which date was his seventy-seventh birthday. Mr. Starrett is the inventor of various machinists' tools, the first one being the combination square, now generally used by machinists, carpenters, etc.

A. L. Kern of the Studebaker Corporation, South Bend, Ind., who has been identified with that concern for a number of years in connection with the designing of dies and tools and the developing of a new steel frame dump wagon, has resigned his position. Mr. Kern has not as yet decided upon future plans.

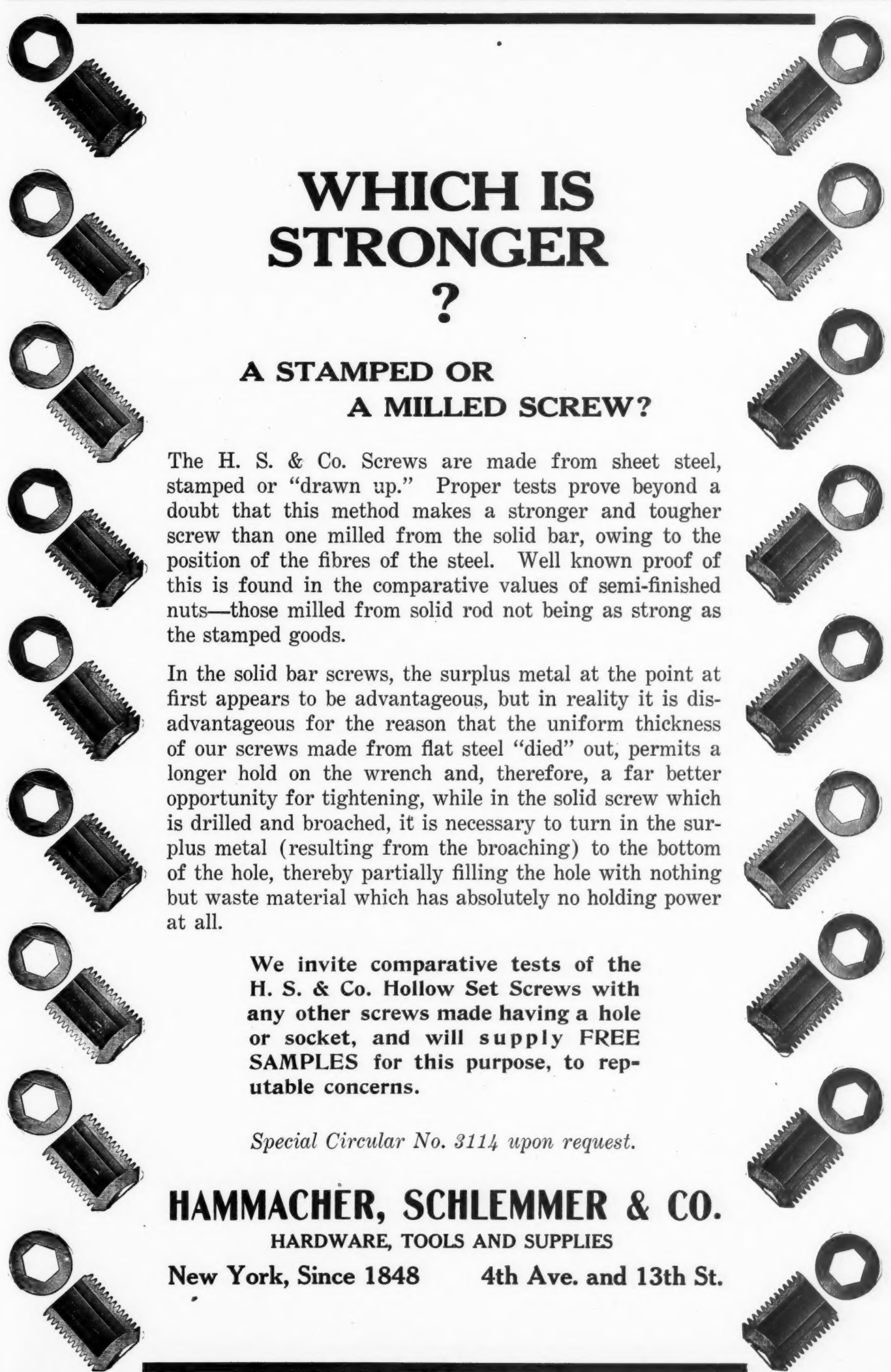
George M. Harden, for a number of years treasurer of the Philadelphia Pipe Bending Co., Philadelphia, Pa., has resigned his position with that company, and will continue in the same line as district sales agent for the Whitlock Coil Pipe Co., Hartford, Conn. Mr. Harden has established offices at 518 Drexel Bldg., Philadelphia, for the sale of the various products of the company.

\* \* \*

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A decorative border of various screws and nuts surrounds the central text. The border consists of alternating hexagonal nuts and screws, arranged in a circular pattern around the main content.

## WHICH IS STRONGER?

### A STAMPED OR A MILLED SCREW?

The H. S. & Co. Screws are made from sheet steel, stamped or "drawn up." Proper tests prove beyond a doubt that this method makes a stronger and tougher screw than one milled from the solid bar, owing to the position of the fibres of the steel. Well known proof of this is found in the comparative values of semi-finished nuts—those milled from solid rod not being as strong as the stamped goods.

In the solid bar screws, the surplus metal at the point at first appears to be advantageous, but in reality it is disadvantageous for the reason that the uniform thickness of our screws made from flat steel "died" out, permits a longer hold on the wrench and, therefore, a far better opportunity for tightening, while in the solid screw which is drilled and broached, it is necessary to turn in the surplus metal (resulting from the broaching) to the bottom of the hole, thereby partially filling the hole with nothing but waste material which has absolutely no holding power at all.

We invite comparative tests of the H. S. & Co. Hollow Set Screws with any other screws made having a hole or socket, and will supply FREE SAMPLES for this purpose, to reputable concerns.

*Special Circular No. 3114 upon request.*

## HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

New York, Since 1848

4th Ave. and 13th St.

## COMING EVENTS

**May 15-16.**—Semi-annual meeting of the National Machine Tool Builders' Association at the Hotel Astor, New York City. James H. Herron, secretary, 2041 East Third St., Cleveland, Ohio.

**May 20-23.**—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers' Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

**May 26-29.**—Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York City.

**May 26-31.**—Convention of the Association Technique de Fonderie and foundry exhibition under its auspices in the premises of the Ecole Nationale d'Arts et Metiers, Paris, France. E. Ronceray, 9-11 rue des Enviergen, Villa Faucheur, Paris.

**June 10.**—Departure from New York City, of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

**June 11-13.**—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

**June 16-18.**—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

**August 16-23.**—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

**September 17-23.**—Third International Congress of Refrigeration to be held in Chicago, Ill. For further information address the secretary-general, Mr. J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

**October 10-17.**—Eighth Annual Foundry and Machine Exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. Forty-five concerns were represented in the exhibition held in Buffalo last year. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago.

**October 14-16.**—Annual convention of the Allied Foundrymen's Associations. Hotel La Salle, headquarters, Richard Moldenke, Watchung, N. J., secretary.

## NEW BOOKS AND PAMPHLETS

**Electrical Instruments and Meters in Europe.** By H. B. Brooks. 88 pages, 6 by 9 inches. Published by U. S. Department of Commerce and Labor, Washington, D. C., as Special Agent Series No. 66.

**Essentials of Electricity.** By W. H. Timble. 271 pages, 4 1/2 by 7 inches. 224 illustrations. Published by John Wiley & Sons, New York City. Price \$1.25 instead of \$1.50 as stated in the review notice in April.

**Proceedings of the Twentieth Annual Convention of the International Railroad Master Blacksmiths Association.** Edited by A. L. Woodworth, Lima, Ohio. 348 pages, 5 1/2 by 8 1/2 inches. A. L. Woodworth, Lima, Ohio, secretary and treasurer.

## SOCIETIES, SCHOOLS AND COLLEGES

**Clarkson School of Technology, Potsdam, N. Y.** Bulletin of information for 1913-14.

**Syracuse University, Syracuse, N. Y.** Bulletin of information for 1913 including the summer session from July 7 to August 15.

**Armour Institute of Technology, Chicago, Ill.** Bulletin of general information for 1912-13 on the courses in mechanical engineering, electrical engineering, civil engineering, chemical engineering, fire protection engineering, architecture, etc.

**Columbia University, New York City.** Bulletin of information on summer session for 1913 comprising courses in agriculture, architecture, metallurgy, chemistry, civil engineering, electrical engineering, mechanics, mechanical drawing, etc.

**New Haven Manufacturers' Exhibit Association, New Haven, Conn.** Souvenir book of New Haven Manufacturers' Exhibit Association illustrating booths and exhibits of goods shown in the association's permanent exhibit by the manufacturers of New Haven.

**University of Wisconsin, Madison, Wis.** announces that the thirteenth annual six weeks' summer school of the College of Engineering will open June 23. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying; other subjects may be taken in the College of Letters and Science. The university issues a bulletin on the summer school which may be

obtained from F. E. Turneure, dean of the university.

**'Buyer's Club' of America,** is an organization proposed by H. E. Gilman of the Marathon Motor Works, Nashville, Tenn., to bring closer together those connected with the purchasing end of various industrial and manufacturing organizations. The plan is to provide headquarters either in New York or Chicago, using preferably the top floor of some hotel, centrally located. Mr. Gilman points out that there is no such organization in existence to-day and if traffic men, engineers and men of other vocations of life can maintain a club, purchasing agents should also be able to maintain a club with resulting advantages to themselves and their concerns.

## NEW CATALOGUES AND CIRCULARS

**Utica Drop Forge & Tool Co., Utica, N. Y.** Catalogue of "Utica" nippers and pliers, comprising a large line for all purposes.

**Ingersoll-Rand Co., 11 Broadway, New York.** Form No. 3312 on "Imperial XB-2" two-stage air compressors with underneath intercooler.

**Pawling & Harnischfeger Co., Milwaukee, Wis.** Bulletin 101 on "P & H" single line grab buckets for handling coal, ore, and other loose material.

**Crocker-Wheeler Co., Ampere, N. J.** Bulletin No. 148, superseding Bulletin No. 104 on direct-current generators for railway service and other heavy duty, 150 to 1500 K. W. capacity.

**Illinois Stoker Co., Alton, Ill.** Catalogue of mechanical stokers of the moving chain grate type. The catalogue illustrates the construction of the furnace and grate, and shows a number of installations.

**Hisey-Wolf Machine Co., Cincinnati, Ohio.** Bulletins Nos. 201 and 901 on portable electric Scotch radial drills for direct and alternating currents, and portable electric reamers for direct current, respectively.

**Firth-Sterling Steel Co., E. S. Jackman & Co., agents, 710 West Lake St., Chicago, Ill.** Leaflet on Firth-Sterling special chisel steel for hand chipping chisels, blacksmiths' chisels and sets, pneumatic hammer chisels, etc.

**Pawling & Harnischfeger Co., Milwaukee, Wis.** Booklet entitled "Drilling and Boring Operations in Railway Shops," illustrating the use of Pawling & Harnischfeger horizontal drilling and boring machines on locomotive cylinders.

**Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y.** Catalogue No. 24-B on "Seneca Falls" quick-change-gear engine lathes, "Star" screw-cutting engine lathes, "Seneca Falls" speed and wood turning lathes, and attachments.

**Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill.** Bulletins 137, 138 and 139 on Chicago "Giant" rock drill, tappet type; Chicago "Giant" rock drill mountings; and appendices for Chicago "Giant" rock drills, respectively.

**Pennsylvania Pneumatic Co., Erie, Pa.** Bulletin illustrating the Barr "unit-compound" air compressor in various types of steam, belt and electric drive. The air compressor is of the two-stage type, one piston acting for both stages.

**Electric Controller & Mfg. Co., Cleveland, Ohio.** Booklet entitled "Electrical Arithmetic," containing problems and answers which deal with the conditions in and around manufacturing plants and show advantages of electrically-operated machinery.

**Ashcroft Mfg. Co., 85-89 Liberty St., New York City.** Circular of paper testers and thickness gages for paper makers, containing valuable information on paper in general, standard sizes of paper, useful rules for paper box board buyers, envelope scale, etc.

**Smith-Serrell Co., Inc., 90 West St., New York City.** Bulletin No. 18 on the Francke flexible coupling for steam and gas engines, steam and water turbines, dynamos, motors, shafting, motor boat couplings, etc., made by the Francke Co., New Brunswick, N. J.

**National Tube Co., Frick Bldg., Pittsburgh, Pa.** N. T. C. Bulletin No. 12, containing much "boiled down" information on pipe under the following heads: "Uniformity," "Chemical Composition," "Physical Properties," "Bursting Strength," "Thread," "Full Weight Pipe," "Spellerizing," "Cohesion," "Tests," "Specifications," etc.

**Dodge Mfg. Co., Mishawaka, Ind.** Booklet on the Dodge capillary self-lubricating bearing which describes the phenomenon of capillary attraction, illustrating it with a number of interesting views, and showing the construction of the new bearing which feeds oil to the shaft by means of a simple ingenious construction acting on the capillary principle.

**Putnam Machine Co., Fitchburg, Mass.** (Managing, Maxwell & Moore, Inc., 85 Liberty St., New York City, selling agents.) Bulletin on heavy pattern double-headed driving wheel lathes built in 79-inch, 85-inch, 90-inch and 100-inch sizes. The bulletin illustrates details of construction of the lathe and shows the forming tools used for roughing and finishing tires.

**Pittsburg Emery Wheel Co., 603-604 Park Bldg., Pittsburg, Pa.** Pamphlet entitled "Standard Tapers for Sides of Safety Shape Wheels" by Charles G. Smith, president of the company, advocating the adoption by grinding

wheel makers of one standard taper for the sides of wheels intended for use of safety collars. The taper recommended is 3/4 inch per foot. See article in April MACHINERY.

**Reliance Electric & Engineering Co., 1056 Ivanhoe Rd., Cleveland, Ohio.** Bulletin No. 1010 on "Reliance" adjustable speed motor, Type AS, armature shifting design. This direct-current motor runs at any speed and develops a constant output over any range up to 1 to 10, with no electric controller. Applications of the motor to various types of machinery are shown, including many machine tools.

**Bickford Machine Co., Greenfield, Mass.** Booklet entitled, "Tap Making Simplified," by O. S. Bickford, illustrating and describing modern methods and machinery employed in the rapid and economical production of thread cutting taps. The matter is divided into two chapters on "Machine Screw Taps" and "Hand and Machine Taps," each illustrated with machines especially designed for tap manufacture.

**Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, Pa.** Catalogue of "Arguto" oilless bearings printed in colors, illustrating cylindrical bushings and thrust washers, loose pulley equipment, clutch pulley equipment, countershaft equipment, special shapes of bearings, tension hooks for drawing rollers, etc. Claims made for these bearings are long life, permanent lubrication, elimination of repairs, reduced friction, etc.

**Marvin & Casler Co., Canastota, N. Y.** Catalogue of the Casler off-set boring head which is used both as a drill chuck and as a boring-tool holder, but especially for the latter. The catalogue illustrates uses of the boring head in the lathe, drilling and milling machine. A recent improvement is an adjustable boring-bar which is fixed to the boring head. This bar increases the stiffness of the tool and its capacity for deep holes.

**Charles H. Bealy & Co., 118-124 N. Clinton St., Chicago, Ill.** Catalogue on Bealy spiral disk grinders, band polishing machines, grinding fixtures, exhausters, accessories, pressed steel ring wheel chucks, spiral circles, cement, glue, oil and other supplies. The catalogue illustrates a large variety of disk grinding machines and gives the specifications for many more not illustrated which apply to the conditions found in a wide variety of metal manufacturing and wood-working.

**A. E. Quint, Hartford, Conn.** Illustrated catalogue No. 12 on Quint's vertical turret drilling, tapping and chucking machines. Light and heavy styles of multiple spindles with spindles ranging in number from four to twelve. These turret machines are so constructed that only the spindle in use is running, the others remaining stationary until indexed into the operating position. All spindles work to one center so that work may be fastened in a fixed position until finished.

**Industrial Instrument Co., Foxboro, Mass.** Bulletin No. 73 on Foxboro thermometers and thermographs, comprising three general classes, viz., 1. Depending on pressure caused by the expansion of a liquid and covering ranges from -60 to 200 degrees F; 2. Depending on the pressure of saturated vapor of a volatile liquid and having a working range of from -50 to 400 degrees F; 3. Depending on the expansion of an inert gas and covering ranges from -60 to 800 degrees F. The bulletin illustrates recording thermometers and various forms of charts used with them.

**Cleveland Automatic Machine Co., Cleveland, Ohio.** Catalogue of 184 pages on "Cleveland automatics," containing a fund of valuable information on the machines and attachments built by this company. Especial attention has been given to those features which would naturally interest the prospective purchaser. The Model "A" automatic machines, with capacities from 3/4 to 7 1/2 inches, are first illustrated, and opposite each illustration are given the important dimensions. Following are plan, end and rear views of the Model "A" and a description of some important operating features. The various attachments for this model are then illustrated and described. At the end of the Model "A" section, there is a two-page group of typical parts produced on the various sized machines of this model. Each piece is numbered for identification, so that anyone interested can readily obtain information regarding the method of machining, rate of production, etc. The arrangement described in the foregoing has been followed for the other models. The latter part of the catalogue contains illustrated descriptions of certain important parts and attachments, many of which are applicable to more than one model. The simplicity of setting up a Cleveland automatic is illustrated by a view showing the operator in the four important positions relative to the machine. On the opposite page the adjustment for each position is explained. Some of the other features described are the double cross-slides; feed roll indicator and regulating wheel; third spindle-speed attachment; new positive-acting belt-shifter; new style chuck operating segment with adjustable cams; worm-gear and feed regulating disk; rotary oil pump; overhanging turning attachment with extra cutting head; independent cut-off and thread-rolling attachment; special box mill for taper or irregular forms; and various cross-slide and turret tools. The different methods of driving the spindle heads to obtain the best results under different conditions are clearly shown by line drawings, as well as the arrangement of the overhead drive for the various sizes and models.

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—II

Letter	Name	Composition by percentage					Miscellaneous
		Copper	Tin	Zinc	Iron, Maximum	Lead, Maximum	
B-c	Commercial brass	64-68		32-34	2.0	3.0	
D-c	Muntz metal	59-63		39-41		0.6	
F	Brazing metal	84-86		Remainder	0.06	0.3	
G	Gun bronze	87-89	9-11	1-3	0.06	0.2	
H	Journal bronze	82-84	12.5-14.5	2.5-4.5	0.06	1.0	
M	Valve bronze	87	7	Remainder	0.06	1.0	
Mn-c	Manganese bronze	57-60	0.75	37-40	1.0		Aluminum, 0.5; manganese, 0.3.
Mo-c	Monel metal	Remainder			6.5		Aluminum, 0.5; nickel, 60 (min.).
N-c	Cast naval brass	59-63	0.5-1.5	Remainder	0.06	0.6	
P-c	Phosphor bronze	80-90	6-8	Remainder	0.06	0.2	Phosphorus, 0.3.
S-c	Screw pipe fittings, brass	77-80	4	13-19	0.1	3.0	
Ni	Nickel						Nickel, 97 (min.).
Cu	Copper	99.8 (Min.)					To be free from sulphur and other impurities and metals.
Zn	Zinc (rolled plates for boilers or slabs)			98+ (Min.)	0.08		
Sn	Tin		99.6 (Min.)				
Pb	Lead (1) Lead (2)					Min. 99+ 97+	
Mo-c	Monel metal (ingots or shot)				3.0		Nickel, 60 per cent (min.); manganese, 2 per cent (min.); balance copper, with amounts of other non-injurious ingredients

\* The figures given are approximate and are a guide as to the proportions of the elements except those for lead, aluminum, and iron, which are maximum limits.

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—I

Letter	Name	Purposes for which suitable
B-c	Commercial brass	Name and number plates; cases for instruments; oil cups; distributing boxes.
Cu-r	Copper	Copper pipe and tubing.
D-c	Muntz metal	Brazing metal, and all flanges and fittings that are to be brazed.
F	Brazing metal	All composition valves 4 inches in diameter and above; expansion joints, flanged pipe fittings, gear wheels, bolts and nuts, miscellaneous brass castings, all parts where strength is required of brass castings or where subjected to salt water, and for all purposes where no other alloy is specified.
G	Gun bronze	Composition valves; Safety and relief, feed check and stop, surface blow, drain, air, and water cocks, main stop, throttle, reducing, sea, safety sluice, and manifolds at pumps.
		Condenser, Distiller, Feed-water heater, Oil cooler. (Heads, shapes and water chests.)
		Pumps: Air-pump casing, valve seats, buckets, main circulating, water cylinders, valve boxes, water pistons, stuffing boxes, followers, glands, in general the water end of pumps complete except as specified.
		Stuffing boxes: Glands, bushings for iron or steel boxes.
		Blowers: Bearing boxes.
		Miscellaneous: Distance pieces.
		Journal boxes: Grease extractors; steam strainers, separator, casing for stern tube and propeller shafts, propeller hub caps.
		Bearings: Main, stern tube, strut and spring.
		Spring bearings: Glands and baffles.
G	Gun bronze	Reciprocating engine: Intermediate and low pressure relief valves and casings, crosshead brasses, crank-pin brasses, eccentric straps and distance pieces.
H	Journal bronze	Journal boxes, guide gibs, bushings, sleeves, slippers, etc. Reciprocating engine: Valve stem crosshead bottom brass; link block gibs, suspension link brasses.
M	Valve bronze	All valves below 4 inches in diameter, for steam and general purposes, for which the material is not otherwise specified; hose couplings and fittings.
Mn-c	Manganese bronze	Propeller hubs, blades, engine framing, and composition castings requiring great strength.
Mo-c	Monel metal	Same as for Mn-c, and pump liners, valve seats, and castings requiring great strength, hardness and incorrodibility; shaft nuts and caps.
N-c	Cast naval brass	Valve handwheels, hand-rail fittings, ornamental and miscellaneous castings, and valves in water chests of condensers.
P-c	Phosphor bronze	Castings where strength and incorrodibility are required.
S-c	Screw pipe fittings	For composition screwed fittings.
Ni	Nickel	For valve seats.
A	Admiralty metal	Condenser, distiller, feed-water heater, and evaporator tubes.
B-a	Benedict metal	Condenser, distiller, feed-water heater, and evaporator tubes.
D-r	Muntz metal	Bolts and nuts not subject to action of salt water.
P-r	Phosphor bronze	Pump rods, valve stems, valve springs, etc., exposed to salt water.
Mn-r	Manganese bronze	Roller rounds, used principally for propeller blade bolts, air pump and condenser bolts, and parts requiring strength and incorrodibility.
Mo-r	Monel metal	Roller rounds, used principally for propeller blade bolts, air pump and condenser bolts, and parts requiring strength and incorrodibility, and pump rods.
N-r	Roller naval brass	Roller rounds, used principally for propeller blade bolts, air pump condenser bolts, and parts requiring strength and incorrodibility, and pump rods, tube sheets, supporting plates, and shaft for valves in water heads for condensers.
B-r	Commercial rolled brass	Sheet brass: For liners, trim, etc.
		Brass pipe: Boiler dry pipe, hand rails.
		Distributing oil tubes and water pipes.
		Commercial brass rod for trim, and purposes where strength and incorrodibility are not required.
W	Antifriction metal	Lining bearings.

U.S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—III

Letter	Name	Composition by percentage					Miscellaneous
		Copper	Tin	Zinc	Lead, Maximum	Iron, Maximum	
A	Admiralty.....	70 (min.)	1 (min.)	Remainder	0.075	0.06	
Be-r	Benedict nickel..	84-86	.....	.....	.....	.....	Remainder nickel.
B-r	Sheet brass and piping	60-70	.....	Remainder	0.5	.....	
B-r	Commercial brass rod	60-68	.....	Remainder	3.0	.....	
Cu-r	Copper.....	99.5 (min.)	.....	.....	.....	.....	
D-r	Muntz metal.....	59-62	.....	Remainder	0.6	.....	
P-r	Phosphor bronze*	85-95	5-10	4 (max.)	0.2	0.06	Phosphorus, 0.15.
Mn-r	Manganese bronze*	57-60	0.5	37-40	.....	1.0	Manganese, 0.80.
Mo-r	Monel metal.....	Remainder	.....	.....	.....	8.5	(Nickel, 60 (min.; aluminum, 0.5(max.)
N-r	Rolled naval brass	59-63	0.5-1.5	Remainder	0.2	0.06	

\* The figures given are approximate and are a guide as to the proportions of the elements, except those for lead, aluminum, and iron, which are maximum limits.

White Metal

Composition: 3.7 per cent of best refined copper, 88.8 per cent Banca tin, 7.5 per cent of regulus of antimony. (Well fluxed with borax and resin in mixing.)

Turbine Materials

Blading and binding strips may be made of the following compositions:

- 1.—Monel metal.
- 2.—Composition: 71-73 per cent copper; remainder zinc; lead not to exceed 0.2 per cent.
- 3.—Cupro-nickel: 79-81 per cent copper; remainder nickel; iron not to exceed 0.75 per cent.
- 4.—Composition: 53-56 per cent copper; 1.5 per cent nickel alloy; remainder zinc; lead not to exceed 0.5 per cent.
- 5.—Phosphor bronze.

Calking Strips

Composition: 62-63 per cent copper; remainder zinc; lead not to exceed 0.6 per cent.

Dummy and Gland Strips

- 1.—Naval rolled brass.
- 2.—Composition: 71-73 per cent copper; remainder zinc; lead not to exceed 0.2 per cent.

Thrust Rings

Composition: 82-84 per cent copper; 12.5-14.5 per cent tin; 2.5-4.5 per cent lead.

COMPOSITION OF MISCELLANEOUS ALLOYS

Alloys	Antimony	Blancmets	Copper	Gold	Iron	Lead	Nickel	Silver	Tin	Zinc	Cadmium
Brass, common yellow.....	.....	.....	61.6	.....	.....	2.9	.....	.....	0.235.3	.....	.....
Brass, to be rolled.....	.....	.....	32	.....	.....	.....	.....	.....	1.510	.....	.....
Brass castings, common.....	.....	.....	20	.....	.....	.....	.....	.....	2.51.25	.....	.....
Brass castings, hard.....	.....	.....	25	.....	.....	.....	.....	.....	4.52	.....	.....
Brass propellers.....	.....	.....	8	.....	.....	.....	.....	.....	1 0.5	.....	.....
Gun metal.....	.....	.....	9	.....	.....	.....	.....	.....	1	.....	.....
Copper flanges.....	.....	.....	9	.....	.....	.....	.....	.....	0.261	.....	.....
Muntz metal.....	.....	.....	6	.....	.....	.....	.....	.....	1.4	.....	.....
Bronze statuary.....	.....	.....	91.4	.....	.....	1.87	.....	.....	1.75.58	.....	.....
German silver.....	.....	.....	2	.....	6.5	.....	7.9	.....	.....	.....	.....
Britannia metal.....	50	25	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chinese silver.....	.....	.....	65.1	.....	12	.....	18.02.58	.....	.....	.....	.....
Chinese white copper.....	.....	.....	20.2	.....	.....	.....	15.8	.....	1.812.7	.....	.....
Medals.....	.....	.....	100	.....	.....	.....	.....	.....	.....	.....	.....
Pattern letters.....	15	15	.....	.....	.....	70	.....	.....	.....	.....	.....
Pinchbeck.....	.....	.....	5	.....	.....	.....	.....	.....	.....	.....	.....
Babbitt metal.....	2	.....	0.5	.....	.....	.....	.....	.....	.....	.....	.....
Bell metal.....	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....
Chinese gongs.....	.....	.....	40.5	.....	.....	.....	.....	.....	.....	.....	.....
White metal, ordinary.....	28.4	.....	3.7	.....	.....	.....	.....	.....	.....	.....	.....
White metal, hard.....	.....	.....	35	.....	.....	.....	.....	.....	.....	.....	.....
Metal to expand in cooling.....	16.7	8.8	.....	.....	.....	75	.....	.....	.....	.....	.....
Pewter.....	17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Spelter.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Type metal.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Solders—	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Newton's, melts at 212 deg. F.....	8	.....	.....	.....	.....	5	.....	.....	.....	.....	.....
Rose's, melts at 201 deg. F.....	2	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Very fusible, melts at 195 deg. F.....	50	.....	.....	.....	.....	25	.....	.....	.....	.....	.....
Less fusible, melts at 199 deg. F.....	5	.....	.....	.....	.....	3	.....	.....	.....	.....	.....
Tin solder, coarse, at 500 deg. F.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....
Tin solder, ordinary, at 360 deg. F.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Tin solder, melts at 225 deg. F.....	50.8	.....	.....	.....	.....	27.8	.....	.....	.....	.....	.....
Brazing, hardest.....	.....	.....	8	.....	.....	.....	.....	.....	.....	.....	.....
Brazing, hard.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Brazing, soft.....	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....
Brazing, softest.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Copper to copper.....	.....	.....	55	.....	.....	.....	.....	.....	.....	.....	.....
Copper to iron.....	.....	.....	80	.....	.....	.....	.....	.....	.....	.....	.....
Iron solder.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
Steel solder.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
Fine brass work.....	.....	.....	8	.....	.....	.....	.....	.....	.....	.....	.....
Pewter solder, ordinary.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pewter solder, soft.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lead solder.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aluminum solder, soft.....	45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aluminum solder, hard.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gold solder.....	.....	.....	1	24	.....	.....	.....	.....	.....	.....	.....
Silver solder, hard.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Silver solder, soft.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

\* 25 parts aluminum. † 1 part brass wire.